

**FORMER MARCHON WORKS,
WHITEHAVEN**

**Proposed Residential Redevelopment
Preliminary Ground Conditions Report**

For: Whitehaven Developments

March 2017

R1533-R01-v2 Final

DOCUMENT CONTROL SHEET

Report Title: Former Marchon Works, Whitehaven
Proposed Residential Redevelopment
Preliminary Ground Conditions Report.

Client: Whitehaven Developments

Report Reference Number: R1533-R01

Report Status: Final

Version: v2

Report Date: 22nd March 2017



	Name	Position	Signature	Date
Author	A F Smith BSc PhD MCIWM SiLC	Partner		21/03/2017
Reviewer	B J Thomas BSc MSc CEnv MCIWEM	Partner		22/03/2017

Document Revision Record:

Version	Report Status	Date	Details of Revision
V1	draft	10/03/17	Draft for comment
V2	draft	20/03/17	Includes additional shaft information, other minor edits
V2	final	225/03/17	Issue

CONTENTS

1. Introduction
2. Information Sources
3. Development History and Current Status
4. Site Characterisation
5. Conceptual Model and Risk Assessment
6. Conclusions and Recommendations

DRAWINGS

- D01 Site Layout and Features
- D02 URS Investigations Plot Boundaries

APPENDICES

- A. Site Maps and Photographs
- B. Site Investigation Logs

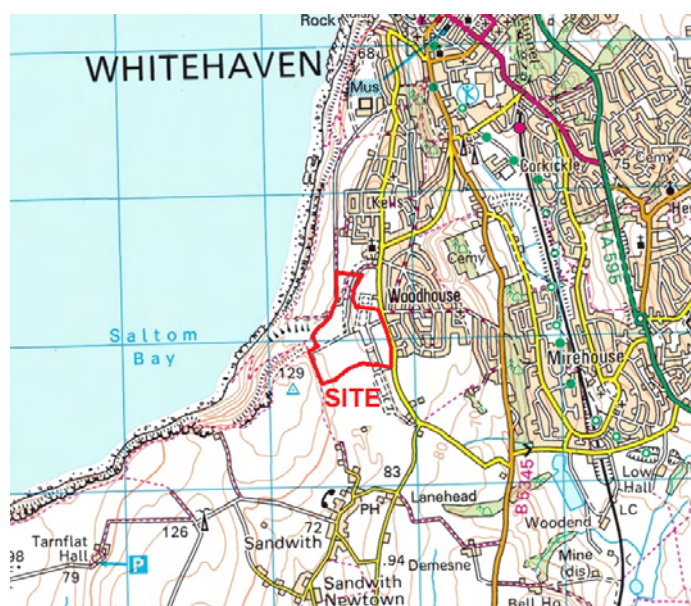
1. Introduction

1.1. Smith Grant LLP (SGP) was instructed by Daineswell Ltd. Project Manager on behalf of Whitehaven Developments Ltd. to undertake a preliminary desk study review of ground conditions and contamination across the area of the former Marchon Works at Whitehaven, Cumbria that is being proposed for redevelopment to residential use. Site details are as follows:

Table 1.1: Site details

Address	High Road, Woodhouse, Whitehaven, Cumbria
National Grid Reference	296650, 516140
Local Authority	Copeland Borough Council (CBC)
Site Area	~21 ha
Current Nature of Site	No current use; open land and disused works.
Site Access	From High Road, Woodhouse
Proposed use	Residential development including houses with private gardens and public open space

Figure 1.1: Site Location



Reproduced with the permission of the Ordnance Survey @Crown Copyright Licence No. 100005799

1.2. This report has been produced to identify potential constraints to redevelopment associated with any contamination at the site and the surrounding environs, and to determine what further information, if any, is needed to support a planning application for residential development. The report describes the findings of a desk study (phase 1) review of historical mapping, geological data and previous site investigation reports provided to SGP by Whitehaven Developments. The assessment methodology follows the framework described in the EA / DEFRA Contaminated Land Report 11: 'Model Procedures for the Management of Land Contamination' 2004.

- 1.3. The Marchon Works site lies to the south of Whitehaven town, flanked by the Woodhouse Estate to the northeast, and open country on other sides. The site includes the locations of the former Croft and Ladysmith Collieries and associated coke ovens, and an alabaster plant using locally extracted gypsum rock. A by-products plant was operated for a short period in the 1930s to recover coal distillation products that would typically include ammonia, benzene and naphthalene compounds, phenols, oils and tars. During the 1940s a chemical company commenced the manufacture of firelighters at the site. Subsequently the site was developed as a major chemical works by Albright & Wilson, manufacturing detergents and surfactants using site-produced sulphuric and phosphoric acids in conjunction with imported fatty acids, alcohols and alkalis; other fine chemicals were also produced. The works was later taken over and operated by Rhodia before eventual closure and decommissioning. The works extended to the south beyond the proposed residential site boundary, and historical activities and contamination in these areas is only referred to in connection with any possibility of cross-boundary migration of contamination or pollution.
- 1.4. Due to past and current pollution of controlled waters (streams and springs linked to the site) the site was determined as Contaminated Land under Part IIA of the Environmental Protection Act 1990 by Copeland Borough Council. The site was classified as a Special Site because of impacts to controlled waters and remediation obligations were therefore administered by the Environment Agency. Rhodia instructed environmental consultants URS to undertake various site investigations and monitoring and to design and verify remediation works in connection with the Part IIA designation. These URS reports form the main basis of this review.

2. Information Sources

- 2.1. The principle sources of published information consulted in the preparation of this report include:

Table 2.1: Information Sources

reference and date	author and source	purpose and information content
Topography, geology, hydrogeology and hydrology		
Promap, accessed December 2016	Ordnance Survey (OS) mapping	general mapping including topography, local development, watercourses and public rights of way
http://mapapps.bgs.ac.uk/geologyofbritain/home.html , Accessed December 2016	British Geological Survey (BGS)	distribution of geological units at surface and depth and scanned borehole logs.
http://www.ukradon.org/information/ukmaps Accessed December 2016	Health Protection Agency	Web based mapping defining radon affected areas in England & Wales

reference and date	author and source	purpose and information content
BRE 211	Radon: Guidance on Protective Measures for New Buildings, 2007	mapping identifying required radon protective measures in England and Wales
www.environment-agency.gov.uk [Accessed December 2016]	EA	information on landfills, flood risk zones, groundwater resources etc.
Historical data		
Ordnance Survey mapping	Landmark Information Group	Historical mapping at 1:2,500, 1:10,000, and 1:10,560 from 1871 onwards.
Aerial/satellite photography	Various sources	Historical images of site
Environmental Sensitivity		
106698707_1_1 Purchased November 2016	Landmark Information Group: Envirocheck Report	Hydrogeological, waste, geological, industrial, hazardous substances and sensitive land use information
www.magic.gov.uk Accessed December 2016	DEFRA	web-based interactive map containing information on nature conservation areas and Nitrate Vulnerable Zones

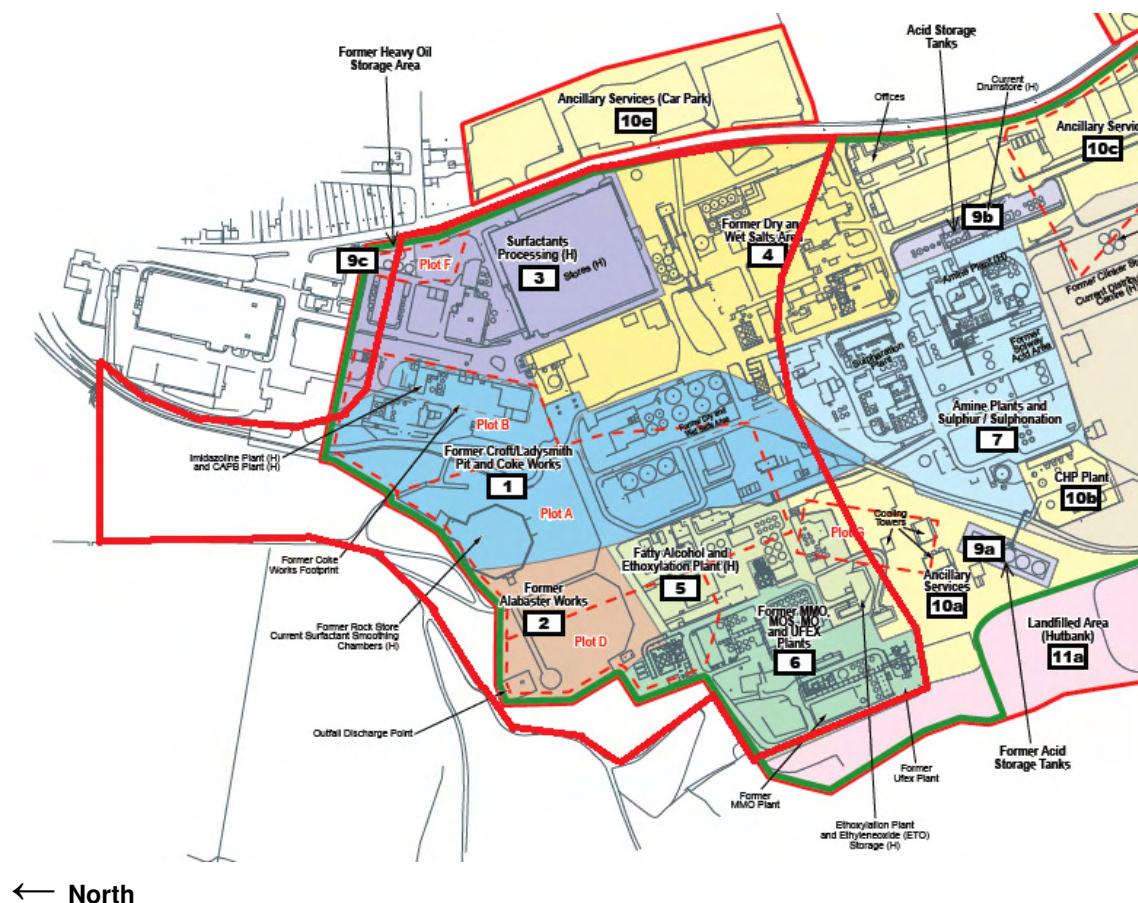
2.2. Previous Site Investigations

2.2.1. The site has been subject to extensive phased investigations initially associated with the previous Environmental Permit for the works, and more recently in connection with the Part IIA notification and with voluntary remediation works undertaken by Rhodia. A very substantial body of information is provided within URS documentation produced on behalf of Rhodia; this is summarized in the URS Contamination Remediation Statement (Final Version 13, 4th February 2008) (CRS v13).

2.2.2. Initial investigations were organised according to zones of the site based upon the major activities carried out (see drawing below); the proposed residential development area includes all or parts of Areas 1 to 6, 9c and 10a:

- Zone 1 - former Ladysmith Pit, included pit, railway, coke works and storage, more recently housed organic chemical plants and effluent processing areas;
- Zone 2 - former Alabaster Works and part of former effluent processing area / works effluent drain;
- Zone 3 - surfactants processing, stores, bulk oil storage;
- Zone 4 (northern part only) - wet and dry salts area, included organic chemical manufacture, with various plants and tank farms;
- Zone 5 - fatty alcohol and ethoxylation plants;

- Zone 6 - former chemical manufacturing including phosphoric acid production (MMO, MOS, MO plants) and waste treatment (UFEX plant);
- Zone 9c (southern part) – former tank farm
- Zone 10a (northern part only) - ancillary services: cooling towers, fire water and treatment basins and unused land.



2.2.3. Following the initial investigations, certain plots within the former works were identified as requiring further investigation and risk assessment in order to satisfy Part IIA requirements; the scope of these investigations was agreed with the Environment Agency. These plots are detailed above and on Drawing 01, and include Plots A, B, D, F and the northern part of G. The targeted investigations of contamination “hot-spots” within the proposed residential development area, together with those for the above zones are outlined below:

Table 2.2 summary of URS targeted contamination investigations

Plot	Source: CRS v13 appendix	Approximate area (ha)	Intrusive entries	Average spacing of entries (m)
A	C	3.72	50 (35 tp, 13 ws, 2 bh)	27
B	D	1.37	70 (61 tp, 8 ws, 1 bh)	14
D	F	1.15	24 (15 tp, 9 ws)	22
F	H	0.19	11 (6 tp, 3 ws, 2 bh)	13
G (north)	I	0.11	3 (1 tp, 1 ws, 1 bh)	19
Total		20.51	202*	32

* includes entries within area outside defined plots; tp – trial pit; ws – window sampler borehole; bh – cable percussion borehole

2.3. The URS site investigation findings are reviewed below. The level of investigation carried out was considered to be satisfactory for the purposes of the Part IIA remediation requirements and the Contaminated Land designation was discharged by CBC as a consequence. The average spacing of entries and information produced is considered by SGP to be sufficient for the purposes of assessing the suitability of the site for the proposed change of use and to produce an outline remedial strategy to prepare the site for residential development.

2.4. It is noted that approximately 3.83 ha of the proposed residential development land lies outside to the north and west of the former works boundary and previous extent of investigations. This land is either undeveloped greenfield or has previously been occupied by railway tracks where the risks from contamination should be reasonably predictable (by reference to the DoE Industry Profile: “Railway Land”); the absence of intrusive information on ground conditions within this part of the site is not considered to be a significant constraint at this stage.

2.5. Site Inspection

2.5.1. A site inspection was carried out by Dr A F Smith SiLC, SGP Partner, on 23 January 2017.

3. Development History and Current Status

3.1. Historical Uses

3.1.1. A summary of significant historical features, developments, and land uses recorded on historical mapping and photography is provided in Table 1 below.

Table 3.1: Summary of Relevant Development History

Source	Site	Surrounds
1866 OS map (1:500)	Croft Pit (coal) in centre of site with well and tramroad leading north;	Open land with scattered houses and farms; High Road to east; farmstead of Langdale (later Lingydale) in northwest

Source	Site	Surrounds
1874 OS map (1:2,500)	No significant changes	Lime kiln, quarry and rifle range to northwest; 3 mine levels (alabaster) to west
1899 OS map (1:2,500)	Croft Pit expanded with second rail line to north; rail connection to west to Barrowmouth Alabaster Works; house to west adjacent to site boundary (later named Alabaster Cottage)	Barrowmouth Gypsum mine and Aikbank Quarry to west
1925 OS map (1:2,500)	Colliery renamed Ladysmith Pit, with enlarged and reconstructed pithead complex, second shaft and additional industrial structures (washery and coke ovens) to north; Alabaster Works marked as disused	Gypsum mine and quarry to west marked as disused
1938 OS map (1:2,500)	Aerial ropeway shown extending west from washery to coastal cliff	Woodhouse residential estate constructed to east of High Road
1957 OS map (1:10,560)	New industrial buildings outlined to east of colliery	No significant changes
1961 OS map (1:1,250)	Mine marked as disused, with former pithead buildings largely removed; extensive chemical works developed across much of site, with tip area on southern boundary, and banks indicating creation of development plateaux	Works plant and railway lines extend to south; new quarry present on site of former Hutbank Cottages to southwest of site; unlabelled structure and spoil tips to south of quarry assumed to be new anhydrite drift mine entrance; aerial ropeway from coal washery no longer shown, but conveyor leads to spoil heaps to west
1967 OS map (1:1,250)	Site labelled as chemical works with various structures including sub-stations, tanks, cooling towers and a chimney	Hutbank quarry extended north and labelled as anhydrite
1979 OS map (1:10,000)	Several large works buildings on western side of site no longer shown, with new plant in central areas; Alabaster Cottage no longer shown	Hutbank Quarry marked as disused
2003 aerial photo	Former Alabaster works building and coal washery removed, octagonal shaped structure (rock phosphate store) present in north; field in northernmost part of site is grassland	Hutbank Quarry infilled and restored to grassland; aerial ropeway from washery to west removed and former spoil tips restored to grassland; some clearance of works buildings and regrading shown to south of site
2008 aerial photo	Site is cleared of all above ground structures, with concrete slabs and roadways remaining, and areas of bare ground (possible demolition rubble); gas governor compound present alongside High Road in south of site	Former works buildings all cleared with the exception of warehouse and office buildings alongside High Road to north of site

3.2. Ground conditions

3.2.1. URS site investigation findings within the defined contamination hot-spots are summarised below:

Table 3.2: Summary of Identified Contamination

Zone	uses	relevant information from URS
1.	former Croft / Ladysmith Pit, coke works then organic chemical plants and effluent processing areas, producing surfactants, inorganics (caustic), imidazoline and acetic acid	includes most of Plot A and most of Plot B <u>Plot A</u> – URS concluded that further remediation under Part IIA was not needed – however residual contamination includes localised hot-spots, e.g. TP631A – oil, naphthalene and cyanide; WS115 – TPH (diesel) <u>Plot B</u> – URS concluded that no remediation was required; the SI findings note the presence of PAH hot-spots and extensive heavy concrete foundations
2.	former Alabaster Works and part of former effluent processing area / works effluent drain	includes much of Plot D (also extends into zones 5 and 6); reference to naphthalene contamination <u>Plot D</u> - investigations found contamination by chlorinated solvents, VOCs, PAHs and metals; further investigation for Pt IIA controlled waters risk assessment was recommended (May 2007) around: TP708D - chloroform TP706D - PAH WS123, WS416, WS717D – metals and naphthalene
3.	surfactants processing, perfume building, stores, bulk oil storage, and possible ammonia	
4.	wet and dry salts area, included organic chemical manufacture such as alcohols (methanol), esters and petrol additives, with various plants and tank farms	no identified hotspots
5.	fatty alcohol and ethoxylation plants; associated substances such as alcohols, esters, amides, amines, acetic acid, ammonia, barium, copper, chromium, hydrochloric and nitric acids	includes part of Plot D and Plot G – see comments under Zone 2 and Zone 10a respectively; reference to naphthalene contamination and voids in underlying limestone formed as a result of acid leaks; one void referred to near to WS130

Zone	uses	relevant information from URS
6.	former MMO, MOS, MO and UFEX plants, used for chemical manufacturing including phosphoric acid production	includes part of Plot D – see comments under Zone 2; 2 voids in bedrock referred to 60m northwest of Plot G below former tank farm
9c.	bulk heavy fuel oil storage	includes part of Plot F – former bulk oil storage tanks – previously subject to remediation, URS investigation found some residual oil / diesel contamination; further monitoring was recommended but no remediation due to remote location of receptors away from designated Part IIA receptors (although free phase oil found above sandstone minor aquifer)
10a.	Ancillary services – cooling towers, fire water and treatment basins and unused land	includes part of Plot G – investigations found elevated TPH, naphthalene and other PAHs requiring further investigation, some timbers in mixed fills

4. Site Characterisation

4.1. Physical Environment

4.1.1. The former works site occupies a shallow valley that flattens to the north, but with rising ground to the east that has been remodelled to form a series of development plateaux and banks. The banks are generally landscaped grassland, with relict concrete slabs on the levelled areas linked by roadways and former railway tracks.

4.1.2. The site is largely drained to the north, but with a watershed near the southern boundary, south of which there is a general slope towards Sandwith Beck to the south of the former works and outside the proposed residential development site. The topography suggests that gravity drainage and shallow groundwater flows from the remaining area of the former works including associated industrial waste landfills will all flow away from the subject site. Therefore, the potential for polluting leachates to enter the site from external areas of the former works appears to be negligible.

4.1.3. Relict structures and ground obstructions taking the form of base slabs, footings, piles, cable and pipe tunnels, drains and sumps can be anticipated across the majority of the site. No underground storage tanks have been identified within the site. Under conventional brownfield development all such potential obstructions would be removed from below development area during the re-engineering of the site unless these would be at sufficient depth below the finished development levels to not create issues relating to obstructions to foundations or underground services, or give rise to concern with respect to potential instability. One argument has been

advanced for retaining slabs as these might be forming localised capping which serves to isolate residual contamination and protect it from leaching into the groundwater; this matter is discussed further below.

4.1.4. Made ground is mostly formed from reworked natural materials including clay, silt, sand, gravel and cobbles,

4.1.5. The previous site investigations have noted voids formed in the Evaporite bedrock at certain locations. This may result from natural dissolution processes, but could have been exacerbated by leaks or spills of acidic fluids at locations associated with previous acid manufacture and use within the plant. All of the most recent sulphuric acid manufacturing plant lies outside the southern site boundary, however some of the older smaller processes making or using sulphuric acid may have been located within the subject site. Localised dissolution of bedrock will require further investigation and foundation solutions for new development similar to the techniques typically required over naturally weathered (karstified) limestone or chalk bedrock surfaces.

4.1.6. The two mineshaft locations were inspected by URS who reported in March 2007 as follows:

Table 4.1: Information on Mine Shafts

Shaft	Grid ref.	URS Observation
Croft	NX 9660 1588	<i>"No visible mineshaft or cap and no visible area of subsidence to indicate weakness in the existing cap. This area is currently covered in compacted brick and concrete rubble from demolition works. It is understood from Fred Proud of Rhodia that this shaft was well capped because it was proposed to develop and build upon the area above. It was not possible to see the state of the cap beneath the rubble."</i>
Ladysmith	NX 9654 1588	<i>"Like the Croft shaft, it is understood that this shaft was well capped as it was built upon with newer areas of plant. No visible shaft cap or entrance was apparent during the walkover survey, though a number of concrete plinths, with the remains of thick metal T and H bars were noted which may have once supported the above ground machinery above the shaft. The area is on the edge of the road, which once bordered the Phosphoric Acid storage tanks and the surrounding area has been levelled and consists of compacted brick and concrete rubble."</i> URS also noted on a geological section drawing that the Ladysmith Shaft extended to 254m depth and was filled and capped in 1997.

4.2. Chemical Contamination

4.2.1. The site has been well characterised as a result of the previous Part IIA designation, with detailed investigations having taken place in the key areas of interest identified by the Environment Agency. It should be noted that the northernmost parts of the site lie outside the Part IIA site boundary and have never been determined as Contaminated Land within the

meaning of the Environmental Protection Act 1990.

4.2.2. The site has been generally affected by alkaline pH and elevated sulphates, phosphates and surfactants in the made ground, plus low-level poly-aromatic hydrocarbon (PAH) and metal contamination associated with ash and slags, and local hot-spots of hydrocarbons.

4.2.3. Generally, outside the oldest parts of the works in the northeast associated with the former coking works and original chemical works, the contamination was localised and sporadic. The coking plant area (Plot B) contains the more significant contamination and is typical of such plants, being characterised by a range of by-products from coal gasification ranging from coal tars to petrol and diesel-range hydrocarbons and phenols. Observations of localised oils or tars in the made ground extending into the natural soils and bedrock surface were noted in a few entries, together with rubble filled cellars and at least one void. It is possible that tar-filled sumps or pipes may be present in this area.

4.2.4. Contamination levels were found to be sufficiently low for the Part IIA designation to be withdrawn without requiring any specific treatment or removal of contamination from the subject site, on the basis of use of the site as open space with casual public access. The principal reason for the original determination was pollution impact upon controlled waters, and since decommissioning of the works it has been found that water pollution has diminished to levels that no longer pose a significant environmental risk.

4.2.5. Hotspots of other contaminants could exist, particularly around former bulk oil and diesel stores and effluent storage/treatment areas. Inspections and observations during site preparatory works will enable any such deposits to be identified and remediated as necessary in order to ensure that the site is made suitable for the proposed future residential use and significant sources of pollution to controlled waters are addressed.

4.3. Radioactive Contamination

4.3.1. Rock phosphate minerals imported to the site contained naturally elevated concentrations of uranium. Most uranium would have been removed during phosphorous extraction either via the effluent stream or in the fine solids deposited at the off-site UFEX landfill. The concentrations of naturally occurring radioactive material (NORM) associated with wastes from the site would typically be sufficiently low for them to fall within regulatory exemptions for radioactive substances for disposal purposes.

4.3.2. Previous assessments of residual radioactivity resulting from phosphate ore processing have determined that no significant levels of radioactivity are present, and the site has not been determined as Radioactive Contaminated Land under Part IIA legislation. Further screening assessment will be required during site preparatory works for development to check that the

previous assessments remain appropriate when access is gained to additional areas of the site.

4.4. Biological Hazards

4.4.1. No invasive weeds have been identified within site.

4.4.2. No potential sources of pathogenic agents have been identified within the site

5. **Conceptual Site Model and Risk Assessment**

5.1. Methodology

5.1.1. Information from the previous site investigations has been used to determine the source-pathway-target relationships identified in the outline Conceptual Site Model (CSM). Preliminary risk assessment has been undertaken by comparison of contaminant concentrations in various media (soil, groundwater and ground gas) to generic screening criteria. These are values appropriate to the intended residential end-use of the site, and indicate whether potentially unacceptable risks to receptors are likely to exist, requiring either more detailed site-specific risk assessment or remediation to break the potential contaminant linkage.

5.2. Sources

5.2.1. Made ground extends across the majority of the site and is variably contaminated, the majority of contamination being from substances that are relatively immobile, including PAHs, metals and sulphates. Surfactants and phosphates may also be present, but are unlikely to pose a significant human health risk, although they were a major consideration in the original Part IIA designation of the site with respect to controlled waters. Surfactants are readily water-soluble and degradable, and are likely to have considerably declined in concentrations since the dates of the investigations, except perhaps where isolated below hard covers. However, given that many of the concrete bases within the plant reflect the original plant layout, it follows that any leaks or spills of liquids onto slab surfaces during the operation of the works would have been most likely to have entered the site drainage or to have infiltrated the unsaturated ground outside the slabs rather than to have accumulated underneath the slabs.

5.2.2. Certain areas of the site have been identified where more significant contamination by either volatile, fluid or significantly water-soluble substances are present. These include very localised areas of liquid tars and oils associated with the former coke works and bulk oil storage tanks. Localised areas largely in the northeast also contain high concentrations of volatile organic compounds (VOCs) that could pose vapour hazards from prolonged human exposure and inhalation.

5.2.3. Areas of mixed fills in former basements or tanks have also been identified, again largely in the

northeast of the site, and some of the fills contain various unsuitable materials including organic materials that could act as sources of gases and vapours. However, generally across the site there have been no significant sources of ground gas identified, and the majority of made ground and natural soils are inert in terms of gassing potential.

5.2.4. Asbestos contamination, either in the form of fragments of asbestos cement products, laggings or dispersed fibres has not been found in any significance in previous site investigations, and no evidence for asbestos in demolition rubble was observed during the preliminary walkover inspection. These observations suggest that care was taken during the dismantling of the works to remove asbestos sources.

5.2.5. Radioactive contamination is not thought to be significant within the site, with radioactivity at natural background levels.

5.2.6. As with any chemical works site, the principal contamination sources are likely to be found accumulated within the relict drainage system and old sumps, pits and tunnels. These structures will have typically trapped and contained the contamination. Site investigations may not always identify such localised features, which may only be encountered during clearance and preparatory earthworks involving the systematic stripping of sub-structures.

5.3. Potential Targets

5.3.1. The principal vulnerable receptors for residential development of the site will be:

- construction workforce;
- neighbouring residents adjacent to the site;
- future residents;
- on-site building structures and infrastructure;
- vegetation within gardens and soft landscaping areas;
- shallow groundwater linked to the future site drainage system, or Sandwith Beck;
- deep groundwater linked to the Byerstead Spring and Saltom Bay, Irish Sea

5.3.2. Existing residents of housing alongside the site would not be subject to any long-term increase in exposure to site contaminants as a consequence of development. To the contrary, any such potential exposure (possibly via the migration of volatile hydrocarbons) would decrease as a consequence of remediation of potential sources in the northeast of the site. Remediation works could potentially cause short-term releases of airborne contaminants meaning that careful management and monitoring will be required to avoid any impacts.

5.3.3. It is understood that the Part IIA determination was withdrawn, as evidence demonstrating absence of significant impacts on Controlled Waters was submitted to and agreed with the regularity authorities. It is noted that pollution levels at Byerstead Spring declined as soon as

the plant ceased operations, and the time taken for dye tracer to travel from the site to the spring was very rapid. On this basis, the current status of the site is not causing significant impact, although potential localised sources of water pollutants are known to remain.

5.3.4. The issue to consider is, therefore, whether short-term disturbance during remediation and preparatory earthworks could give rise to fresh releases of pollutants, or whether long-term removal of existing site slabs would result in additional leaching of pollutants to controlled waters.

5.3.5. There are no designated ecological or heritage features on or adjacent to the site that could potentially be affected by site contamination.

5.4. Human Health Risk Assessment

5.4.1. Health risks to development contractors are typically addressed through workplace safety measures including safe working practices, protective equipment, minimisation of exposure to soils, vapours, dusts and liquids, and through personal and environmental monitoring.

5.4.2. Soil contaminants are likely to be present in low concentrations over much of the site that renders these soils unsuitable for use at shallow depth within future residential garden areas, and possibly soft landscaping; necessitating the use of clean soil cover layers. Most brownfield site developments involve the placing and validation of clean soil layers in gardens, typically 600mm thick, with possible additional protection layers where the underlying contamination levels warrant these. Stable, low-mobility contaminants such as metals and PAHs would not otherwise constrain residential development of the site. Some areas of the site, particularly in the previously undeveloped northwest area, or elsewhere (if regrading removes the made ground down to clean natural strata) may not pose any risk to human health and may not require any further mitigation measures other than verification testing.

5.4.3. The localised areas of volatile hydrocarbons identified particularly under parts of Plot B could pose additional potential health risks via the soil vapour route, with migration into unprotected dwellings where the vapours could be inhaled. However, it is normal practice to specify hydrocarbon-resistant barrier membranes in the construction of houses over potential areas of this type of contamination thereby breaking this potential pollutant linkage. Notwithstanding this mitigation measure, it is expected that all such areas of significant hydrocarbon contamination would be excavated to an appropriate depth, with the impacted soils removed for treatment or disposal.

5.4.4. Although general ground gas risks have not been identified across the wider site, it is possible that following regrading, passive gas protection measures could be included within construction over areas of deeper fills; this is normal precautionary practice for residential development on

deeper made ground.

5.5. Property Risk Assessment

5.5.1. Contaminants with the potential to leach into mains water supply pipes have been encountered in parts of the site and the use of barrier pipe for below ground water pipelines is likely to be required. A pipeline risk assessment may be required by utility providers.

5.5.2. Given the likely presence of sulphates in made ground and natural strata across the site, a detailed assessment of sulphate aggression on concrete sub-structures will be needed.

5.5.3. Geotechnical hazards will include variable and potentially loose made ground, the presence of substructures and possible localised voiding or soft spots in the shallow Evaporite bedrock. These can all be dealt with during the re-engineering of the site in preparation for development, and where necessary, excavation out and backfilling or grouting of any shallow voids.

5.5.4. No risks from deep mining have been identified. The presence of two former mine shafts in the south of the residential site will need consideration in the proposed development layout. Additional treatment of the shafts may be required by the Coal Authority with a nominal no-build stand-off of say 20m radius.

5.6. Controlled Waters

5.6.1. Risks to controlled waters are expected to arise primarily as a result of:

- disturbance of soils during excavation works to remove existing foundations, drains etc. and increased leaching or runoff from freshly exposed soils
- leaching / runoff from any ex situ soil treatment / quarantine area
- long-term leaching from soils exposed / disturbed as a result of preparatory earthworks.

5.6.2. Existing hard cover in the form of concrete slabs and roadways is likely to be of similar or slightly lesser extent than the hard cover that would exist following residential development. The former works drainage system is believed to be blocked or destroyed in some places and it appears that most precipitation across the site soaks into the ground, passing largely via natural fissures, old anhydrite mine voids and the Byerstead Fault to Byerstead Spring. The southernmost part of the site may also lie within the catchment of Sandwith Beck, however any shallow water flows within the former works drainage system will be eliminated as a result of redevelopment.

5.6.3. Many of the former works slabs and roadways are now fissured and provide pathways for direct entry of rainwater to the ground, and existing drains are blocked. The new drainage plans for the proposed development have not been established at this time, however it is likely that they will either feature the use of soakaways in suitable uncontaminated areas, or flow attenuation

and the re-use of the existing surface water outfall. Therefore, overall infiltration is likely to be lower following redevelopment than it is at present, and will not be subject to the current potential for contamination. Given the reduction or removal of existing pollution sources it is apparent that long-term risks to controlled water from the proposed development will be reduced compared to the present situation.

5.6.4. Short-term risks of water pollution from existing site contamination arising during development works may be associated with:

- removal of cover layers and exposure to weathering and drainage of soluble contaminants in soils (primarily surfactants);
- accidental release of residual polluting liquids (dissolved chemicals or liquid hydrocarbons) from tanks / pipes / flooded voids;
- storm runoff of silts and entrained contaminants;
- leaching or runoff from soils treatment or quarantine areas.

5.6.5. The above risks can be mitigated by means of appropriate methods of working, inspection, monitoring and management, and do not pose any exceptional risks compared to many other remediation schemes. It is anticipated that treatment methods may be used for the deposits of contamination by hydrocarbons associated with parts of Plot B or other localised areas, and, if necessary, for any areas of significant residual contamination by surfactants (if present). Treatment methods are expected to involve *ex situ* soil treatment by bio-remediation and/or stabilisation methods within a temporary secure contained treatment area, before reuse of the treated soils. Treatment would be undertaken in accordance with the Environmental Permitting Regulations by a specialist contractor operating under a deployment notice with Environment Agency approval. All earthworks operations involving soils and waste movements and use within the site would be covered under a Materials Management Plan.

5.6.6. In a few site investigation entries in Plot B it was noted that heavy oils or tars had penetrated into natural strata or bedrock. In these situations the risk to controlled waters is minimal due to the very low mobility of such contaminants (which have probably been present for over 60 years). Whilst it is normal practice to remove free product (liquid hydrocarbons) where encountered, it is unlikely that this would either be necessary or feasible where present in bedrock at depth, with no likelihood of migration back to the surface environment.

6. Conclusions and Recommendations

6.1. Planning

6.1.1. National planning policy guidance in relation to contaminated land states that planning authorities should be satisfied that sufficient information exists in order to grant a planning consent, and that the proposed development should be feasible and practicable. Smith Grant LLP has reviewed the extensive site investigation reports available for the site and concludes that these provide a suitable and sufficient basis of factual information for understanding the nature and extent of contamination at the site. This means that the risks from unknown contamination or unforeseen conditions that could compromise development proposals are lower than is normally the case.

6.1.2. Planning consent when granted for potentially contaminated sites will include conditions that specify the measures to be taken prior to development to identify contamination via site investigations, and to inform the preparation of a detailed remediation strategy. However, in order to be satisfied that planning consent may be granted, the planning authority must be satisfied that it understands the potential risks associated with the development. These risks may include the likelihood that contamination exists that for technical, environmental or economic reasons is impracticable to deal with, thereby sterilising part of or all of the development site. We are satisfied that no such risks exist on the site, and that the various issues (listed below) do not pose unusual or unacceptable constraints for residential development on brownfield land.

6.2. Development Constraints

6.2.1. The following matters concerning residential development of the site and their solutions are identified below;

- irregular topography with some steep slopes - remodelling (cut and fill) to suitable development contours
- foundation slabs, sub-structures, loose fills, relict services - systematic strip of obstructions and loose fills with recovery of suitable hard materials (concrete and brick) for crushing and reuse or sale, recovery of scrap metal and timber, and disposal of any other residues
- polluting liquids in tanks, pipes or other voids - pump out and remove from site for treatment or disposal as appropriate;
- general fills with low level contamination - regrade to future development levels to accommodate clean soil cover / service corridors etc.; clean soil cover would be placed in garden areas during house-building with validation of soil depth and quality
- contamination "hot-spots" - excavation and removal to quarantine/soil treatment area for treatment or off-site disposal;
- possible low level radioactivity - previous assessment has ruled this out and precautionary screening only is advised; if sources were encountered then these would be assessed and

- removed to low sensitivity landscape areas if necessary;
 - solution cavities in bedrock - either removed during preparatory earthworks or, subject to size, grouted if below sensitive areas (houses or roads)
- 6.3. Management of the remediation and preparatory earthworks will be required in order to minimise emissions of noise, dust, odour, track-out (mud on roads) and storm runoff. These are normal measures for civil construction projects and will be of limited duration and may be phased according to the development requirements.
- 6.4. Noise emissions will be associated with the breaking out of concrete works, earth-moving, haulage and crushing, with all activities designed to minimise nuisance to the site neighbours. Specific management measures would typically include limiting working hours, numbers of and types of plant, possible temporary screening and monitoring.
- 6.5. Control of fugitive dusts will be predominantly through the maintenance of existing roadways as haul routes for as long as possible, with cleaning and damping down of haul roads as necessary. General dust management may be supported by use of perimeter monitoring of nuisance dust deposition and fine particulates, although it should be noted that naturally elevated background levels of fine particulates may arise from sea salt due to the coastal setting.
- 6.6. Potential for odour nuisance at the nearest housing is likely to be of very short duration as the limited areas of hydrocarbon hot-spots within Plot B are removed. Emissions are typically minimised by use of small phased excavations and avoidance of adverse weather conditions (e.g. low speed winds blowing towards residential receptors).
- 6.7. Recommendations
- 6.7.1. Assuming that planning consent is granted, it is recommended that an updated topographical and drainage survey is carried out as a basis for the design of future development levels and earthworks modelling.
- 6.7.2. Additional site investigation will be required in some areas of the site to fill gaps in previous coverage, further examine locations previously constrained by services, presence of contained liquid contaminants, or extensive sub-structures, and to confirm and update the previous investigation findings. The scope of further investigations and monitoring should be agreed in consultation with the Local Planning Authority and Environment Agency and will be designed with specific respect to the proposed change of use to residential and current risk to controlled waters.
- 6.7.3. Following completion of updated investigations and risk assessment a detailed remediation

strategy will be required. This will specify the measures to be undertaken to remediate the site and will include actions by the earthworks / remediation contractor during the preparatory phase, and mitigation measures against residual contamination to be implemented by the residential house-builder.

6.7.4. The latter measures will be expected to include (over most of the site) provision of validated clean soil cover, installation of gas barrier membranes in foundations, possibly with additional sub-slab venting and/or hydrocarbon resistant membranes in higher risk areas, provision of protected water mains in some areas, and sulphate resistant concrete specification in vulnerable zones. We would expect building foundations to largely involve support in made ground deeper than 2 or 2.5m from vibro-replacement stone columns, and traditional strip footings in other areas, possibly reinforced subject to bedrock integrity. Localised untreated solution voids or soil-filled fissures in the shallow bedrock may require additional remedial grouting.

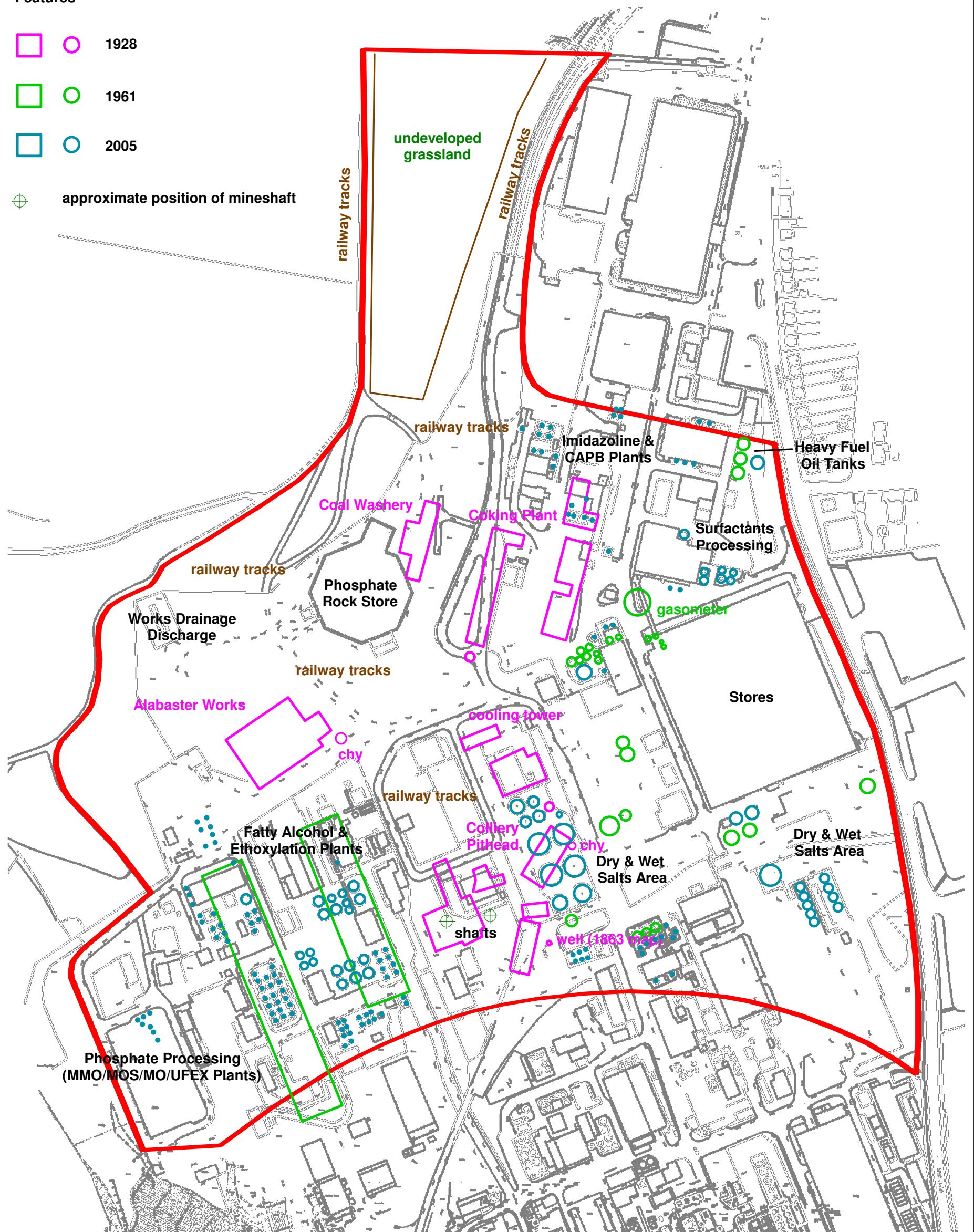
6.7.5. The remediation strategy will need to include full details of environmental monitoring and mitigation measures for the duration of the preparatory works, and details of remediation verification works and completion reporting to be provide by both the remediation contractor and subsequently by the residential housebuilder.

DRAWINGS



Historical Building and Tank Features

-   1928
-   1961
-   2005
-  approximate position of mineshaft



Smith Grant LLP
Station House
Station Road
Ruabon, LL14 6DL
Tel: 01978 822367
Fax: 01978 824718

www.smithgrant.co.uk
email: consult@smithgrant.co.uk

Project:

**Former Marchon Wks,
Whitehaven**

Drawing:

**Site Layout
and Features**

Drawn:

SM

Date:

03/01/2017

Job No:

R1533

Checked:

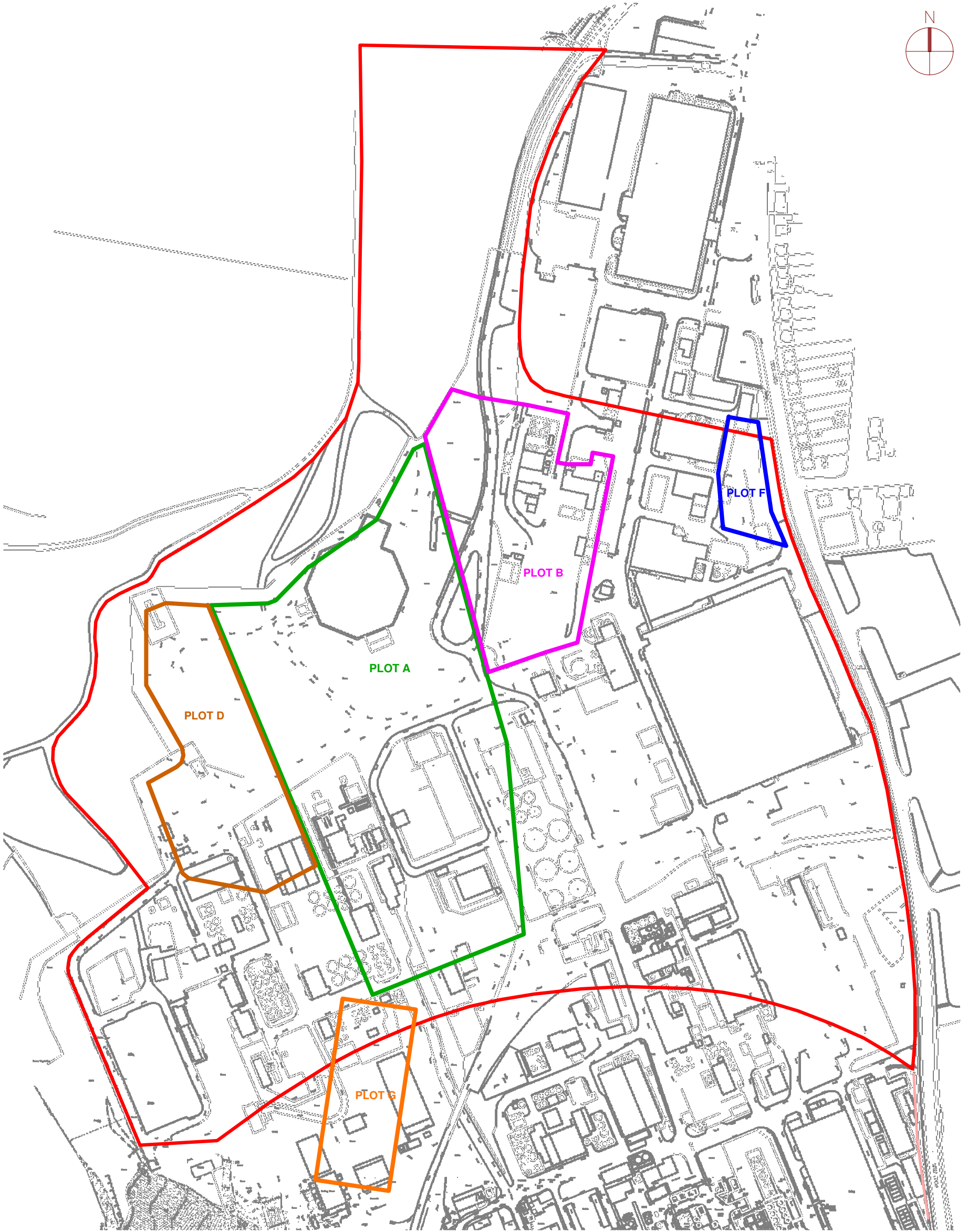
AFS

Scale:

1:2500 @ A3

Drg No:

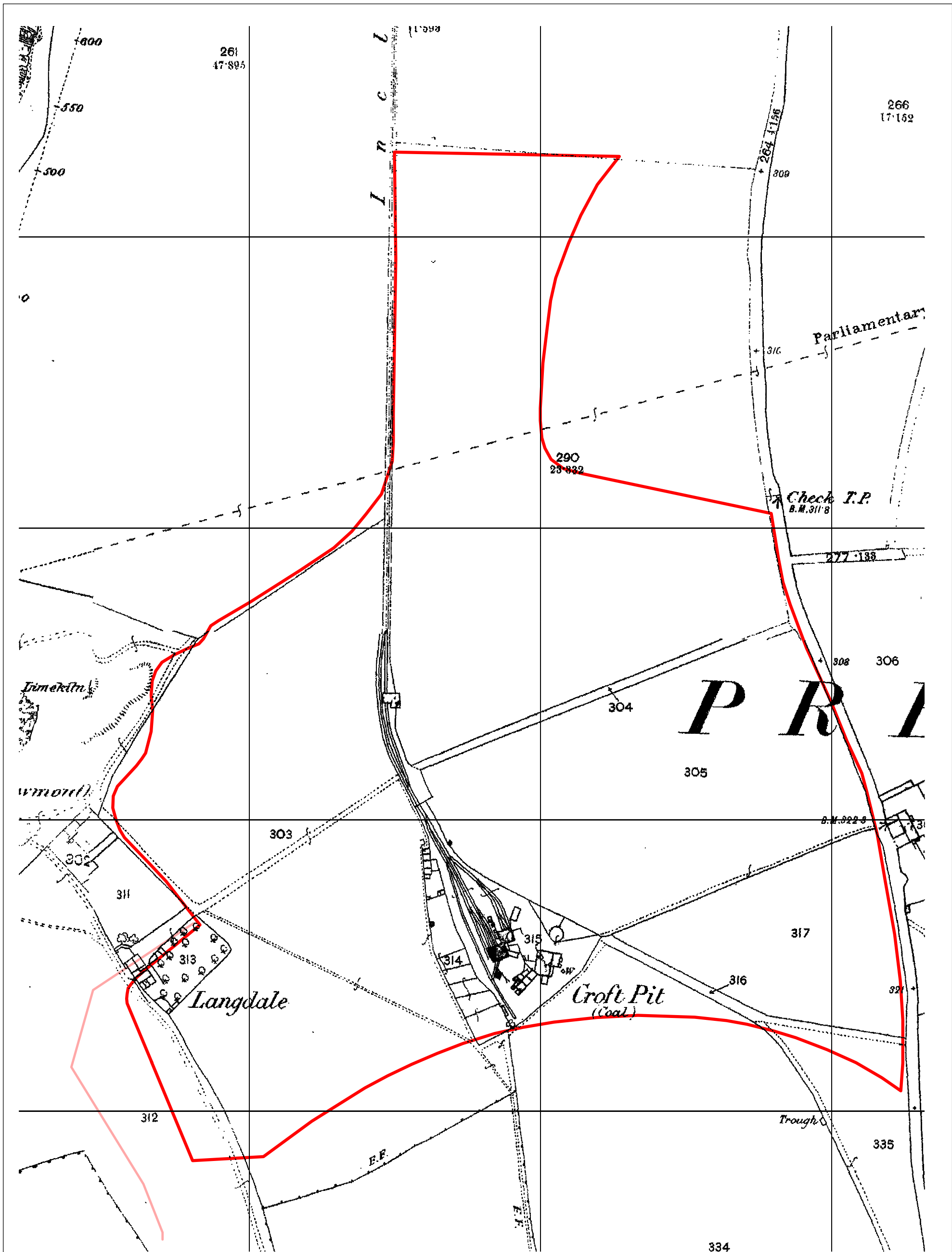
R01-D01



 Smith Grant LLP Station House Station Road Ruabon, LL14 6DL Tel: 01978 822367 Fax: 01978 824718 www.smithgrant.co.uk email: consult@smithgrant.co.uk	Project:	Former Marchon Wks, Whitehaven		Drawn:	SM	Checked:	AFS
	Drawing:	URS Investigations Plot Boundaries		Date:	03/01/2017	Scale:	1:2,500 @A3
				Job No:	R1533	Drg No:	R01 D02

APPENDIX A

SITE MAPS AND PHOTOGRAPHS



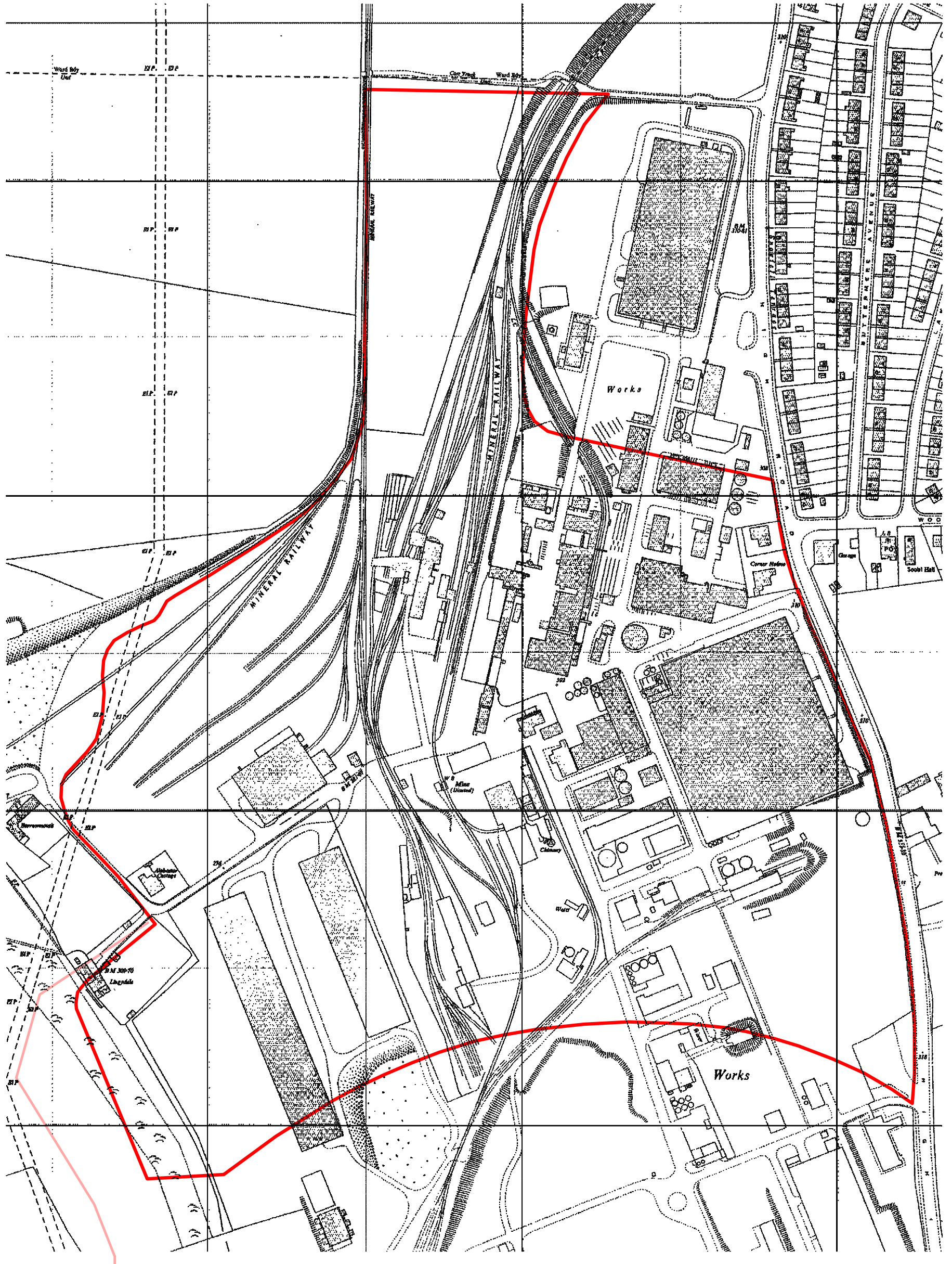
Smith Grant LLP
Station House
Station Road
Ruabon, LL14 6DL
Tel: 01978 822367
Fax: 01978 824718

www.smithgrant.co.uk
email: consult@smithgrant.co.uk

Project:
**Former Marchon Wks,
Whitehaven**

Drawing:
**1863 Ordnance
Survey Map (1:2500)**

Drawn: SM	Checked: AFS
Date: 03/01/2017	Scale: 1:2,500 @A3
Job No: R1533	Drg No: R01-App A D01



Smith Grant LLP
Station House
Station Road
Ruabon, LL14 6DL
Tel: 01978 822367
Fax: 01978 824718

www.smithgrant.co.uk
email: consult@smithgrant.co.uk

Project:

**Former Marchon Wks,
Whitehaven**

Drawing:

**1961 Ordnance
Survey Map (1:1250)**

Drawn:

SM

Date:

03/01/2017

Job No:

R1533

Checked:

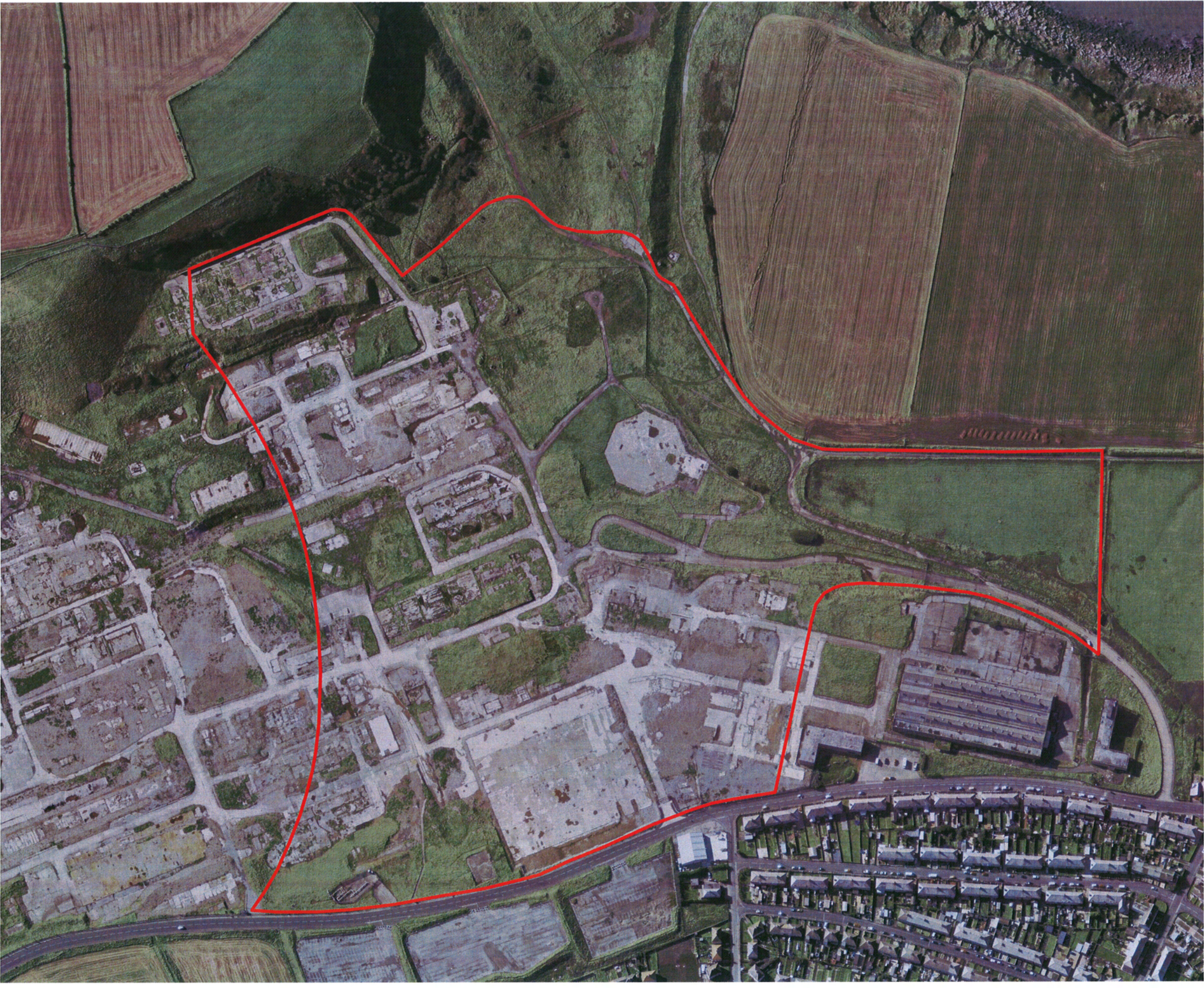
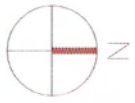
AFS

Scale:

1:2,500 @A3

Drg No:

R01-App A D03



 Smith Grant LLP Station House Station Road Ruabon, LL14 6DL Tel: 01978 822367 Fax: 01978 824718 www.smithgrant.co.uk email: consult@smithgrant.co.uk		Project:	Former Marchon Wks, Whitehaven		Drawn:	SM	Checked:	AFS
Recent Aerial Photograph		Drawing:			Date:	03/01/2017	Scale:	1:2,500 @A3
					Job No:	R1533	Dwg No:	R01 App A D04

APPENDIX B

SITE INVESTIGATION LOGS