



UNITED
BY OUR
DIFFERENCE



PROLOGIS PARK WEST LONDON: REMEDICATION METHOD STATEMENT & OPTIONS APPRAISAL

Prologis UK Ltd

16/10/2105

Quality Management

Issue/revision	Issue 1	Issue 2
Remarks	FINAL	FINAL
Date	06/07/2015	16/10/2015
Prepared by	R. Hares	R. Hares
Signature		Hares, Rob 2015.10.16 15:03:12 +01'00'
Checked by	T. Hasler	T. Hasler
Signature		 tom.hasler@wspgroup.com 2015.10.16 14:55:38 +01'00'
Authorised by	R. Hares	R. Hares
Signature		Hares, Rob 2015.10.16 15:03:27 +01'00'
Project number	70004909_RMS	70004909_RMS
Report number	Final_01	Final_02

PROLOGIS PARK WEST LONDON: REMEDIATION METHOD STATEMENT & OPTIONS APPRAISAL

Prologis UK Ltd

16/10/2015

Client

Prologis UK Ltd

Consultant

WSP UK Ltd
70 Chancery Lane
London
WC2A 1AF
UK

Tel: +44 (0) 207 314 5000

Fax: +44 (0) 207 314 5111

www.wspgroup.com

Registered Address

WSP UK Ltd
WSP House
70 Chancery Lane
London
WC2A 1AF

Tel: 020 7314 5000

WSP Contacts

Dr R. Hares
DDI: +44 (0) 203 116 6028
rob.hares@wspgroup.com

Table of Contents

1	Introduction & Objectives	1
2	Site Background.....	3
3	Previous Reports and Site History	6
4	Conceptual Site Model	12
5	Remediation Objectives and Constraints	15
6	Remediation Options Appraisal.....	17
7	Site Specific Remediation Strategy	18
8	Verification Report.....	28

Figures

Figure 1	Site Location Plan
Figure 2	Site Layout
Figure 3	Remedial Areas

Appendices

Appendix A	Masterplan
Appendix B	Regulatory Framework and Screening Criteria
Appendix C	General Limitations
Appendix D	Remediation Technologies
Appendix E	Qualitative Assessment of Appropriate Technology

1 Introduction & Objectives

1.1 Authorisation

WSP UK Ltd (WSP) was instructed by Prologis UK Ltd (the Client), to prepare a Remediation Method Statement and Options Appraisal for land located at Ironbridge Road North, Hillingdon, Middlesex (the Site).

This assessment was undertaken in accordance with the scope agreed between WSP and the Client as set out in our proposal dated 14th April 2015 (Ref. 70004909_RMS).

1.2 Development Proposals

A hybrid application for a phased comprehensive redevelopment of the Site to provide an overall maximum gross floorspace of 45,000 sqm of light industrial uses (Use Class B1c and / or Use Class B2) and / or storage and distribution uses (Use Class B8) and ancillary offices, together with servicing, parking, access roads and open space is proposed. Full planning permission is sought for Phase 1 containing 18,900 sqm of floorspace in two buildings up to 16.2 metres in height (to ridge), together with associated highways works, open space, hard and soft landscaping, car parking and associated infrastructure. Outline planning permission is sought for Phase 2 for up to 26,100 sqm of floorspace.

In order to achieve a level building formation platform, it is understood that the elevated central portion of the site will be re-profiled. This will involve removal of former infrastructure (including the existing sheet pile walls) and re-grading of the site with the intention to retain all site material where practical.

Vehicular access to the site will be via Horton Road to the north. The two ponds along Iron Bridge Road will be retained with substantial landscaping present along the west, south and eastern boundaries of the Site. Small landscaped strips will also be present along the access roads.

The proposed masterplan is provided as **Appendix A**.

1.3 Scope of Works

This report comprises:

- Review of background information;
- Summary of Relevant Pollutant Linkages as identified through the GQRA;
- Remediation Objectives and Requirements;
- Remediation Options Appraisal of available Technologies;
- Remediation Strategy; and
- Remediation Validation requirements and Validation Plan.

1.4 Sources of Information

Information in this report was obtained from the following documents. It is noted that the site was formerly referred to as 'Stockley Park'.

- Stockley Park Phase 3 Pre-Development Environmental Site Investigation by Ove Arup and Partners Arup Geotechnics, dated February 1998;
- Stockley Park Phase 3 Geotechnical Interpretative Report by Arup Geotechnics, dated December 2000;
- Stockley Park Phase 3 (Dawleywood) Remediation Report by Arup, dated May 2001;

-
- Environmental Statement (ES) Volume 1: Stockley Park Phase 3 by WSP, dated June 2007;
 - ES Volume 1: Main Text Stockley Park Phase 3 by Arup, dated September 2009;
 - Appendix F [to ES 2009]: Ground Contamination Preliminary Risk Assessment Report, Stockley Park Phase 3, by Arup, dated September 2009;
 - Stockley Park Phase 3 Land Quality Report by Arup, dated April 2014;
 - Contamination and Geotechnical Appraisal Report by WSP, dated May 2014;
 - Intrusive Ground Investigation Scope of Works by WSP, dated July 2014;
 - Abnormal Cost Appraisal Report by WSP, dated August 2014;
 - Stockley Park: Preliminary Risk Assessment (Phase 1 Report) by WSP, dated September 2014;
 - Ground Investigation Factual Report by Harrison Group Environmental Ltd (HGEL), dated September 2014;
 - Prologis Park West London: Geo-Environmental Assessment, produced by WSP UK Ltd and dated March 2015;
 - Delineation of Asbestos in Landscaped Bunds: Prologis Park West London, produced by WSP UK Ltd and dated March 2015;
 - Review of readily available geological and hydrogeological maps; and
 - Review of the Environment Agency's (EA) online databases.

1.5 Regulatory Context

This assessment has been undertaken with due regard to Contaminated Land Guidance documents issued by the Department for Environment, Food and Rural Affairs (and its predecessors) including Contaminated Land Report 11 (CLR 11) and with reference to the National House-Building Council (NHBC) reference document Guidance for the Safe Development of Housing on Land Affected by Contamination R&D66:2008. The methods used follow a risk-based approach, with the potential environmental risk assessed qualitatively using the 'source-pathway-receptor pollutant linkage' concept to assess risk as introduced in the Environmental Protection Act 1990 (EPA, 1990).

Further details of the WSP assessment approach are provided in **Appendix B**.

1.6 Confidentiality Statement and Limitations

This report is addressed to and may be relied upon by Prologis UK Ltd.

This assessment has been prepared for the sole use and reliance of the above named parties. This report has been prepared in line with the WSP proposal and associated notes. This report shall not be relied upon or transferred to any other parties without the express written authorisation of WSP. No responsibility will be accepted where this report is used, either in its entirety or in part, by any other party.

This report needs to be read and used in full.

General limitations of the assessment are included in **Appendix C**.

2 Site Background

2.1 Site Location

The Site is located within Stockley Park, in the London Borough of Hillingdon.

The Site is rectangular in shape. Access is via Ironbridge Road North to the east of the Site, which forms the eastern boundary. The site is approximately 12 hectares in area and is centred at National Grid Reference 507267, 180159. A site location plan is provided as **Figure 1**.

2.2 Site Description

The main central portion of the site is predominantly open, cleared land with sparse vegetation. A moderately dense copse of semi-mature trees is present in the north east of the Site and there is dense, overgrown vegetation along the western and southern boundaries of the site. The perimeter of the Site is secured with metal fencing.

The central and north eastern portions of the Site are raised at a height of approximately 2 to 3 m above the remainder of the Site. A central 'T' shaped area was engineered using sheet piling and was designed as part of a former re-development, which was not completed.

The Site is predominantly soft standing with the exception of access roads and a car parking area in the south east of the Site.

Temporary portacabins used by Stockley Park Management suite are located adjacent to the car park in the south east of the Site.

Water features in the form of lined ponds are present along the eastern boundary. A site feature/layout plan is presented as **Figure 2**.

2.3 Surrounding Land Use

The Site is located within a predominantly commercial / industrial area:

- Horton Industrial Estate is located adjacent to the west of the Site.
- A day care centre and nursery is present on the south east boundary of the Site.
- Stockley Golf course is present on the northern boundary of the Site.
- The Grand Union Canal is present along the southern boundary of the Site. The canal is understood to have been constructed with sheet piled walls.
- A mainline railway line is present 100 m to the south.

2.4 Geology

The British Geological Survey (BGS) Map No. 269 Windsor (Solid and Drift) (1:50,000 Series), Map No. TQ07NE and TQ08SE (1:10,000 Series) and geological information provided in the earlier reports (refer to Section 1.3) were reviewed and a summary of the findings is presented in **Table 2.1**.

Table 2.1 Summary of Published Geology

Geological Unit	Description	Aquifer Designation*
In filled / Made Ground	Soft to firm brown clay with sand and gravel Recorded by Arup to be between 0.5 m to 12 m thick.	Not classified
Lynch Hill Gravel Member (hereafter referred to as River Terrace Deposits (RTD))	Sandy GRAVEL to coarse GRAVEL. Remnants are present at the edge of the site boundary. Recorded by Arup to be between 0.0 m to 3.0 m thick.	Principal Aquifer
London Clay	Firm to extremely stiff brown grey CLAY Depth not proven. Arup record >36 m.	Un-productive Aquifer

*Environment Agency (EA) Published Information

WSP note that the 1:10,000 scale BGS map illustrates the site is encompassed in all directions by worked/Made Ground with only remnants of the Langley Silt Member present to the west of the Site.

2.5 Hydrogeology

Arup recorded a perched groundwater body in the Made Ground with the base formed by the London Clay Formation. Based on groundwater level monitoring undertaken between 1997 and 2000, Arup concluded that groundwater flow was towards the south. Arup also recorded that the top of the London Clay Formation was at approximately +28 m Ordnance Datum (OD), with some low areas (where London Clay was excavated to form the clay barrier) of approximately +24.8 m OD. Resting water levels in monitoring wells were recorded between +32 m OD to +34 m OD in the north and between +30.5 m OD to +31.5 m OD in the south.

The generalised topography of the surrounding area falls in level towards the south-southwest.

The Lynch Hill Gravel Member, where present, is classified by the Environment Agency as a Principal Aquifer. These are layers of rock or drift deposits that have high intergranular and/or fracture permeability. As such, these units usually provide a high level of water storage and may support water supply and/or river base flow on a strategic scale.

The Made Ground is not classified and the bedrock (London Clay Formation) is classified as unproductive strata (i.e. with low permeability that has a negligible significance for water supply or river base flow).

The Site is located within an area classified by the Environment Agency as having land of high vulnerability with respect to potential groundwater pollution. The soils are pre classified as high leaching potential due to an urban setting, where the 'worst case' is assumed.

The Site is not located within a groundwater Source Protection Zone (SPZ) for public water supply. Groundwater Safeguard Zones and the Groundwater Drinking Water protected Areas as defined by the Environment Agency.

A summary of licenced groundwater abstractions within a 250 m radius of the site is presented in **Table 2.2**.

Table 2.2 Summary of Licensed Groundwater Abstractions Near the Site

Licence Number	Distance / Direction From Site	Details
TH/039/0036/004	On site	Groundwater abstraction well used for irrigation and storage in the man-made lakes
TH/039/0036/012	250 m northeast	Stockley Park Golf Club – general washing / process washing

2.6 Hydrology

The Site is located within the Thames River Basin District as defined by the EA. A summary of the key hydrological features is presented in **Table 2.3**. A summary of the surface water quality for the Grand Union Canal is provided in **Table 2.4**.

A review of the EA's "what's in your backyard" website indicated that the site is not located within an indicative area of flood risk from rivers. However, isolated areas are at risk of flooding from surface water.

Table 2.3 Summary of Hydrology Features

Feature	Distance / Direction From Site	Details
Lakes	On site	Constructed wetlands as part of the reclamation works. Ponds are groundwater and surface water fed. No details of water quality have been provided.
Grand Union Canal	10 m south	Artificial.
Lakes	60 m north	Artificial, as part of golf course.
Lake	500 m southeast	Formed from infilling of a formal canal spur.

Table 2.4 Summary of Surface Water Quality for The Grand Union Canal

Surface Water Quality	Current	Predicted by 2015 (end of current cycle)
Ecology	Good potential	Good potential
Chemical	Does not require assessment	Does not require assessment

Full details of the construction of the Grand Union Canal in the vicinity of the site are not known, but it is understood that it is founded in the London Clay. The northern wall of the canal (that bounds the site to the south) has been constructed with sheet piling.

3 Previous Reports and Site History

This section provides a summary of the previous use of the Site and specifically describes the phases of intrusive ground investigations undertaken in support of the reclamation scheme and the infrastructure works conducted between 1989 and 2001.

3.1 Historical Ground Investigations

Stockley Park Phase 3 Pre-Development Environmental Site Investigation by Ove Arup and Partners Arup Geotechnics, dated February 1998

The report was designed to provide a consolidated history of the Site and to present the results of the landfill reclamation works conducted between 1989 and 1991. The report was commissioned in order to confirm the suitability of the Site for an intended commercial building and landscape design.

A summary is provided below:

- Prior to the reclamation works, the Site comprised a former brick-earth and gravel extraction pit (from late 19th century to 1935) which was subsequently in-filled from 1948 to 1961 with domestic and commercial wastes.
- Reclamation works involved the preparation of the eastern half of the Site for a commercial use and the western half to be returned to pastoral use. Arup reported that the landfill was removed between 1989 to 1991 and deposited at the north end of the Country Park Golf Course. A clay barrier was constructed to the north and west of the site to act as a barrier preventing ingress of ground gas and groundwater from the Golf Course site. A deep land drain was placed at the '*invert of a gravel filled passive gas vent constructed adjacent to the clay barrier on the golf course side at 29.3 m Ordnance Datum (OD)*'. Leachate was pumped under licence to offsite public sewers to prevent leachate entering the Site. The barrier extended 150 m along the western boundary to '*provide greater security against ingress of leachate or gas*'.
- Arup also recorded that the '*additional section of clay barrier*' along the south of the Site was constructed at this time.
- Arup also record that underground features and obstructions were removed and the resulting void was backfilled with approximately 750,000 m³ of 'inert' material. Arup record that the two ponds along the eastern boundary were constructed by providing a one metre thick compacted London Clay layer above the fill. The top 0.4 m of material in the western half of the site was not compacted.

The site investigation undertaken by Arup in December 1997 comprised eight boreholes to the top of the London Clay and 15 trial pits to maximum depth of 3.4 m bgl. Soil samples collected during the investigation were analysed for contaminants of concern and reported '*no widespread or significant contamination of the soil using ICRL and Dutch Intervention Values (DIV 1994) as guidelines*'.

Arup concluded that the 'inert' fill used in 1989-1991 was 'generally clean' and the groundwater quality was '*generally good*' and not causing significant contamination. Concentrations of carbon dioxide and methane were below trigger levels.

Stockley Park Phase 3 Geotechnical Interpretative Report by Arup Geotechnics, dated December 2000

The report assessed two historic ground investigations to provide information for the design of the foundation and infrastructure works associated with the Phase 3 development. Recommendations for the design of the foundations were based on the following information:

- Site investigation by Wimpey Laboratories in 1982, which identified the presence of landfill materials from 6 to 10 m in thickness comprising domestic refuse on London Clay or thin lenses of sand and gravel all above the London Clay.
- Site investigations by Arup in 1991 on the southeast corner of the Site recorded re-worked natural ground and construction wastes placed along the western edge of the site between 1965 and 1966.

The Arup report produced in 2000 described a site investigation undertaken between June and August 2000. Works comprised 15 No. boreholes to 40 m bgl and 43 trial pits to a maximum depth of 4.1 m bgl. Made

Ground was recorded up to 12 m in thickness overlying London Clay. Gravels were only present in the south-western corner. Contamination testing was limited to hydrocarbon species which were identified in one location TP22 and was further delineated.

A number of trial pits were located over the northern clay barrier. The trial pits identified the barrier to have a slope of approximately 1:4 (as opposed to a 1:2 slope design value given in an earlier Arup report (1998)). The gravel trench used to vent landfill gas was covered by a mound of clay soil and no leachate vents were encountered.

Stockley Park Phase 3 Land Quality Report Arup, dated April 2014

The Arup Land Quality Report provided a summary of the site history and ground conditions for potential purchasers. The report included a summary of the earlier Arup reports described above and a site walkover.

Arup stated that the site walkover did not reveal significant signs of ground contamination.

An updated Conceptual Site Model and risk assessment was undertaken with potential sources of contamination identified as:

- Made Ground;
- Car-storage (point source contamination);
- Road salt storage;
- Electrical sub-stations; and
- Residual contamination from the remedial works that includes soil containing elevated levels of TPH.

Arup concluded that the contamination risk was '*generally low assuming some mitigation during development*' and recommended further site investigation in advance of proposed groundworks to allow for a contemporary assessment in accordance with current guidelines.

3.2 Previous Remedial Works

Stockley Park Phase 3 (Dawleywood) Remediation Report by Arup, dated May 2001

Arup was commissioned to co-ordinate, supervise and subsequent intrusive investigations and subsequent remediation works of areas of contamination identified pre-2000. The ground remediation works were designed to remove hydrocarbon contamination, asbestos-cement board and underground structures.

Arup described an area of hydrocarbon contamination that was identified in the southeastern portion of the Site during excavation work for land drains. The hydrocarbon contamination was subsequently delineated in November 2000. Seven areas were identified, namely Area 1 and 2 (hydrocarbon contamination); Area 3 (UST); two hydrocarbon hotspots (Areas 4 and 7); and two underground concrete interceptor tanks (Areas 5 and 6).

Remedial target concentrations of 1,000 mg/kg for polycyclic aromatic hydrocarbons (PAH); 1,000 mg/kg for mineral oils / total petroleum hydrocarbons (TPH); 50 ppm for field based photo ionisation detector (PID) readings; and <0.1% v/v asbestos, were utilised for these works.

Arup state that '*dig and dump*' was the preferred remediation option, with overburden removed and stockpiled onsite. Contaminated material and underground structures were removed to a licensed landfill (Norlands Lane Landfill, Egham Surrey). Verification was based on visual, olfactory and PID measurements to initially delineate the extent of material removal, with the collection of side wall and base samples for validation testing. Two samples that exceeded remediation validation criteria were left in-situ, on the basis that they were considered to be representative of 'tarmac' and TPH and PAH compounds were identified in a bound form that did not pose a risk to human health receptors.

Arup recorded a total of 9,620 tonnes of mainly hydrocarbon impacted soil was excavated and removed from site. The contamination was generally encountered at a depth of 0.5 m bgl and extended to maximum depth of 2.4 m bgl. Arup recorded that the voids were backfilled with '*suitable material*' from site won and offsite sources.

In total, 36,000 litres of potentially contaminated groundwater was removed from Area 1 and deposited at the Thames Waste Management Camberley Treatment Plant. Liquid contained in the below ground tank was recorded as being disposed offsite as special waste.

Arup record that within an earth bank along the southern boundary, a layer of hydrocarbon impacted material was identified between approximately 1.8 m and 2.1 m bgl. Soil samples were collected and recorded hydrocarbon levels between <10 mg/kg and 2,300 mg/kg). No further remedial works were proposed in that area.

3.3 Recent Ground Investigation Works

An intrusive site investigation was completed by HGEL and supervised by WSP in July to September 2014. Full details are provided within the report entitled 'Prologis Park West London: Geo-Environmental Assessment', produced by WSP UK Ltd and dated March 2015.

The ground investigation was undertaken to assess the following Potential Areas of Concern (POAC): PAOC1 - Imported fill material; PAOC2 - Possible underground tank; PAOC3 - Disused wheel wash facility and former tank; PAOC4 - Void containing refuse/waste; PAOC5 - Electrical sub-station (north west); PAOC6 - Electrical sub-station (south west); PAOC7 - Raised mound; PAOC8 - Raised central building platform; PAOC9 - Gas vents; and PAOC10 - Clay cut off walls assessment.

3.3.1 Ground Conditions

A summary of the strata encountered during the 2014 investigation is presented below.

- **Made Ground** (0.0 - 12.5 m bgl) - Generally described as sandy gravelly CLAY. Gravels included but were not limited to flint, brick, concrete, chalk and clinker. Inclusions of plastic, wood, geotextile, tile, glass and metal;
- **Kempton Park Gravels** (2.5 – 9.0 m bgl) - Predominantly sandy GRAVEL and GRAVEL. Gravels were flint (encountered in extreme west and east of the site only); and
- **London Clay** (3.3 - >15 m bgl) - CLAY with minor inclusions of sand and silt.

3.3.2 Contaminant Sources

A total of ten potential areas of concern were identified for further investigation. No evidence of notable contamination was recorded in the areas of the former underground tank, vehicle washing bays, previously recorded voids or the former sub-stations.

Soil analytical results have identified the presence of asbestos within the 750,000 cu.m of material imported during the reclamation of the Site. The material used to construct the raised platform area and the two discrete mounds were similar in composition to those identified within infilled material across the remainder of the site.

Table 3.1 provides details of the potential sources of contamination and a summary of risk with respect to human health, controlled waters, soil gas in accumulation in structures and ingress of contaminants into potable water supply pipes.

Table 3.1 Sources of identified Contamination and Risk

Source Area	Review of Risk
Fill material imported during the reclamation works c750,000 cu.m	Soil chemical contaminant concentrations were below the relevant assessment criteria and therefore are not considered to pose a human health exposure risk. Within the development footprint, Asbestos Containing Material (ACM) was detected in approximately 20% of soil samples tested across the entire Site at all depths.

Source Area	Review of Risk
	Asbestos Containing Material (ACM) was also identified within the majority of the soil samples located in the landscaped areas within the upper 1 m. Elevated concentrations of Ammonium were detected throughout the groundwater at the Site. No distinguishable contaminant gradient was identified. Ammonium concentrations in soil leachate were also elevated in unsaturated soil across the site. Contaminants that may pose a risk to potable water supply pipes were not identified. Elevated concentrations of CO₂ were identified in two borehole locations only.
Retained Landscaped Areas	Asbestos Containing Material (ACM) was identified within the majority of the soil samples located in the landscaped areas within the upper 1 m. Contaminants that may pose a risk to potable water supply pipes were not identified.
Possible underground storage tank	No underground storage tanks were identified and no evidence of historical contamination was identified within the surrounding area.
Disused wheel wash facility	No evidence of soil contamination was identified within this area.
Void containing refuse/waste	No evidence of soil contamination was identified within this area.
Electrical sub-stations (north west and south west of site)	A slightly elevated concentration of PCB contamination was identified within the vicinity of the electrical sub-station within the north west section of the site. However, the exceedance was marginal, and is considered not to require further assessment or remedial works.
Fill material within raised mounds	The soils identified within these mounds were similar in composition to those identified within the remainder of the Site. No evidence of soil contamination was identified within this area.
Fill materials used to create the raised central building platform	The soils identified within the mounds were similar in composition to those identified within the remainder of the Site. No evidence of soil contamination was identified within this area.
Off-site leachate and gas from the adjacent landfill	Restrictions were imposed within the immediate vicinity of the Clay Barrier and thus ground investigation information in these areas is limited. However, soil, groundwater and soil gas concentrations are low in the exploratory hole closest to the Clay Barriers. Thus no direct evidence was obtained to suggest the Clay Barriers have been compromised.

3.3.3 Asbestos in Soil

A review of **Table 3.1** reveals that ACM is present within fill material present across the Site. The majority of the Site redevelopment will comprise of building footprints and hardstanding. In these areas, no mitigation measures are considered necessary as exposure pathways will be broken, however appropriate precautions will be required during construction works to ensure that site operatives are not placed at risk, such as dust suppression and appropriate PPE.

Only a limited number of trial pits were excavated within the landscaped areas on the western and southern boundaries of the Site due to a 40 m exclusion zone imposed by Stockley Park Phase 3 Ltd and remained an area of potential uncertainty with respect to asbestos contamination.

Asbestos Containing Material (ACM) was identified within the majority of the soil samples located in the landscaped areas within the upper 1 m. The landscaped areas are covered in retained trees and approximately 12,000 m² of open grassed areas. This area was subjected to further assessment (see below).

An intrusive site investigation was completed by HGEL and overseen by WSP along the western and southern boundaries of the Site on the 18th and 19th February 2015 in order to characterise the asbestos in soil contaminant risk. The works involved the excavation of 34 No. hand dug pits to maximum depth of 1.0 m bgl and collection of soil samples for chemical analysis.

In all locations Made Ground was identified and generally comprised a topsoil of gravelly silty sand, over gravelly sandy clay. The gravel component commonly recorded flint, concrete, brick, charcoal, glass, ceramics, metal and clinker as being present.

A total of 37 No. soil samples were analysed for the presence of asbestos containing material, including a suspected fragment of bound asbestos cement. 18 No. soil samples were found to contain asbestos fibres, of which 12 No. recorded concentrations at <0.001% w/w. The maximum recorded soil concentration was 0.005% (w/w) crocidolite in HP110 at 0.9 m bgl.

Suspected cement bound asbestos recorded at HP115 0.5 m bgl was confirmed to be cement bound asbestos (Chrysotile) upon laboratory identification.

It should be noted that asbestos fibres were not detected in the corresponding soil sample at HP115 where the piece of cement bound asbestos was identified.

No visual or olfactory evidence of organic contamination was noted during the investigation.

3.3.4 Ammonium in Groundwater

The groundwater under the Site is impacted with ammonium. Based on the results of the ground investigation the following conclusions can be drawn:

- Leaching of unsaturated soils at the site is potentially adding to the concentration of ammonium in underlying groundwater, however, it is unlikely to be the sole source;
- The River Terrace Deposits in the surrounding area of the site have been extensively quarried/reworked and backfilled with Made Ground and landfill materials and is likely to provide additional external sources of ammonium;
- No designated aquifer unit is considered to be present which would represent a potential receptor (due to extensive gravel extraction);
- Based on the data obtained from the level loggers, the Grand Union Canal is not in hydraulic connection with the groundwater underlying the site and is not deemed to be at risk; and
- The presence of the Clay Barriers and the cohesive nature of the soils have retarded groundwater flow under the site and may have led to anoxic conditions naturally increasing the ammonium levels in groundwater at the site.

Based on the above, it was considered that groundwater conditions do not present a material risk to surrounding controlled water receptors and further remedial works are not likely to result in improved groundwater conditions. Future redevelopment will effectively cap the site and reduce surface infiltration, removing ongoing leaching potential from the unsaturated soils. It should however be borne in mind that site conditions may remain conducive to natural generation of ammoniacal nitrogen following the redevelopment of the Site.

Further confirmatory groundwater monitoring were recommended to support the redevelopment works.

3.3.5 Ground Gas

Four rounds of ground gas monitoring were undertaken. The majority of monitoring results do not provide a gas screening value (GSV) that would suggest gas protection measures are required. However, based on elevated CO₂ readings (>5% v/v) in two locations, namely BH07 and BH10S and the presence of substantial depths of fill material, it is considered prudent that the site is classified as Characteristic Situation 2 – Low Risk

according to the CIRIA Ground Gas Risk Assessment Scheme (CIRIA C665). Gas protection measures for office areas should be incorporated into the redevelopment design.

4 Conceptual Site Model

4.1 Introduction

This chapter summarises the findings of the assessment and identifies the Relevant Pollutant Linkages (RPLs) where unacceptable risks exist that will require remedial measures for the protection of Human Health, Controlled Waters and the wider Environment.

4.2 Assessment

An assessment of environmental impact with respect to potentially contaminated sites is based on identifying and evaluating the following: the significance of contamination sources; the sensitivity of environmental targets; the presence of potential migration pathways; and site-specific factors.

Where a potentially significant source of contamination is identified a detailed quantitative assessment of potential pathways and targets has been undertaken to determine if a credible 'source – pathway – target' linkage may exist. In each case, where such a 'source – pathway – target' linkage may exist the associated environmental risk has been assessed based on the likelihood and severity of the risk. Risk has been classified into the following categories:

- Low No action likely to be required
- Medium Some mitigating action may be required
- High Mitigation action will be required

4.3 Sources

Table 4.1 provides details of the potential sources of contamination and a summary of risk with respect to human health and soil gas in accumulation in structures. All other sources were eliminated during the recent 2014 ground investigation.

Table 4.1 Sources of identified Contamination and Risk

Source Area	Review of Risk
Fill material imported during the reclamation works c750,000 cu.m	Within the development footprint, Asbestos Containing Material (ACM) was detected in approximately 20% of soil samples tested across the entire site at all depths. Asbestos Containing Material (ACM) was also identified within the majority of the soil samples located in the landscaped areas within the upper 1 m. Elevated levels of CO ₂ were identified in two borehole locations only.
Retained Landscaped Areas	Asbestos Containing Material (ACM) was identified within the majority of the soil samples located in the landscaped areas within the upper 1 m.
Fill material imported during the reclamation works c750,000 cu.m	Fill material contained TPH and phenol concentrations in excess of the UK Drinking Water Standards for potable water supply pipes.

4.4 Pathways

The following pathways may be active, after the development of the Site:

- Inhalation of ACM within soils and dusts from the western and southern landscaped areas;
- Migration of ground gas through pore space;
- Direct contact; and

4.5 Receptors

The following are considered Critical Receptors following development of the Site:

- Female Adult Worker (Age Class AC17);
- On Site built structures (accumulation of soil gas); and
- Potable Water Supply Pipes.

WSP has excluded maintenance / construction workers, on the basis that acute risks will largely be mitigated through the adoption of standard health and safety management practices in accordance with the CDM Regulations 2007; Health and Safety at Work Act 1974; with the provision of an appropriate level of Personal Protective Equipment (PPE); tool box talks; and associated risk assessments / method statements to protect against human health exposure to potentially contaminated soil.

On completion of the Construction Phase a Health and Safety File for the Site should be maintained and referenced to highlight potential risks to maintenance / construction workers from acute exposure to potential contaminated land and any residual contaminants.

A summary of Relevant Pollutant Linkages are identified in **Table 4-1**, below.

Table 4-1 Relevant Pollutant Linkages that Require Remedial Action

Relevant Pollutant Linkage	Source	Pathway	Receptor	Assessment
RPL1	Asbestos Containing Material in Landscaped Areas within the Western and Southern section of the Site	Ingestion and Inhalation of contaminated soils and dusts generated from areas that are not covered by hardstand or other surface coverings. Inhalation of dusts from areas that are not covered by hardstand or other surface coverings.	Female Adult Worker (Age Class AC17)	High – Potential for ACM impacted soils in exposed areas to pose a risk to Human Health.
RPL2	Carbon Dioxide generated from Made Ground	Inhalation of gas concentrations released from underlying Made Ground and building up in on-site structures to potentially asphyxiation limits.	Future Site Occupants	Low to Medium – Concentrations of Carbon dioxide have been identified across the site to exceed the 5.0% v/v trigger threshold requiring gas protection measures.
RPL3	Previously unidentified contamination within Landscaped Areas and within Topsoil to	Direct Contact and Ingestion with areas not covered hardstanding.	Female Adult Worker (Age Class AC17)	Low to Medium – Potential for ingestion & direct contact with previously unidentified contamination

Relevant Linkage	Pollutant	Source	Pathway	Receptor	Assessment
		be re-used across the Site			
RPL4		Residual contamination within the shallow Made Ground	Ingress of contamination through the walls of water supply pipes	Potable water supply for the Site	Low – Potential for TPH and Phenol ingress into potable water supply

5 Remediation Objectives and Constraints

This chapter defines the boundary within which remediation options are considered so that the most appropriate overall remediation option can be chosen.

The objectives for remediation are proposed on the basis of the aim to achieve the following:

- A site suitable for residential redevelopment;
- Protection of human health and the environment;
- Contribution to sustainable development whilst minimising adverse environmental impact on off-site locations; and
- Best practicable and affordable remediation strategy for the redevelopment.

The protection of human health and the environment will need to address:

- Unacceptable risks to human health;
- Managing ground gas emissions; and
- Protection of potable water supply.

A summary of the remediation objectives per RPL is provided in **Table 5-1**, below.

Table 5-1 Summary of Remediation Objectives

RPL	Source	Remediation Objectives	
		Aim / Requirements	Action
RPL1	ACM impacted soils locally around the following: Hotspot 1 (HP107/108/109 and 110) Hotspot 2 (HP115) Hotspot 3 (HP123) (Refer to Figure 3)	Removal of ACM impacted soils landscaped areas. Prevention of cross contamination during earthworks on site and the spreading of contamination across the Site	Delineation and removal of ACM impacted soil within Hotspot 1, 2 and 3.
RPL2	Carbon dioxide generated from within the Made Ground	Prevent carbon dioxide from building up at potentially asphyxiating concentrations within built structures on site.	Inclusion of appropriate gas protection measures in the ground floor slab of the proposed offices (associated with each unit) on site in accordance with CIRIA C665 and BS 8485:2015.
RPL3	Previously unidentified contamination within shallow Made Ground	To mitigate exposure risks associated with previously unidentified contamination if encountered during the earthworks across the site, and preventing the potential for cross contamination.	Delineation and removal of impacted soils.
RPL4	Measures required to protect potable water supply	To mitigate risk to potable water supply pipes being installed in contaminated material that could migrate into the water supply and impact future site users.	Use of polyethylene pipe protection measures, such as foil cored barrier pipes.

5.1 Site Specific Constraints

The following are a number of Site specific factors that are likely to affect the choice of remediation solution. These are summarised below:

- The developer does not want the responsibility for long term monitoring;
- The Site layout (building locations / hardstand cover) is defined and cannot be altered;
- Earthworks are required on site to generate the proposed formation level;
- Following demolition it is understood that there is available space onsite for temporary storage and pre-treatment of excavated material, but the location has not been defined;
- Below ground services are not expected to pose a remedial constraint, however, it is understood that some services are live;
- At this stage, design plans for locations of potable water supply have not been finalised, some soils recorded elevated levels of hydrocarbons that may pose a risk to below ground potable water pipes constructed from polyethylene.
- The development works are to include a number of piles that will be driven through the northern Clay Bund and into a thin layer of landfill material clay bund which may give rise to the potential for preferential pathways to be generated and permit the migration of contaminants into the underlying groundwater; and
- The piling method to be used is likely to be continuous flight auger (CFA) and is considered by the EA to be protective against the creation of vertical pathways. Consideration of the environmental impacts associated with the piling works are included within more detail within the WSP Piling Risk Assessment¹, which should be referred to for more information.

¹ Piling Risk Assessment, Prologis Park: West London WSP UK Ltd, June 2015, Ref: 70004909

6 Remediation Options Appraisal

6.1 Introduction

An appraisal has been undertaken taking into consideration technical, logistical and financial aspects of the remediation technology/options and incorporates the staged approach as defined in CLR 11 (2004).

Considering the constraints listed in **Section 5**, the remedial options available to manage unacceptable risks will either:

- Manage (remove, destroy, modify or immobilise) the source;
- Interrupt the pathway; or
- Modify the receptor or the behaviour of the receptor.

The options are designed to manage the source of contamination or interrupt the pathway, modifying receptor or receptor behaviour was not considered. Source management may involve the removal, destruction, stabilisation, or transformation of the source. Pathway interruption may involve either the blocking of the pathway or the destruction or removal of contaminants moving along a pathway.

A wide range of remediation options are available that have been considered by WSP and are assessed on the appropriateness for treating small hotspots of contamination; or design methods that can be incorporated into engineering works, such as a hotspot removal, watching brief; barrier pipes; and gas membranes.

In accordance with CLR 11 a summary appraisal of different remediation technologies is provided as **Appendix D** and a qualitative assessment of the technologies based on costs and benefits; effectiveness; wider environmental effects; regulatory requirements; operational constraints and post remediation legacy issues are provided as **Appendix E**.

Remediation of existing groundwater is not warranted for the reasons outlined in the DQRA and summarised in the **Section 3.3.4**.

7 Site Specific Remediation Strategy

The remediation strategy provides the approach to the mitigation of the identified relevant pollutant linkages (RPL) at the Site. The RPLs have been identified on the basis of the DQRA and information contained in the above Sections. **Figure 3** illustrates areas requiring specific remedial measures with respect to ACM impacted soils.

Table 7-1 provides a summary of the preferred remediation options and information to be collected during the works.

Table 7-1 Summary of Remediation Strategy

RPL	Objective	Preferred Remediation Option	Actions and verification requirements
RPL1	ACM impacted soils locally around the following: Hotspot 1 (HP107/108/109 and 110) Hotspot 2 (HP115) Hotspot 3 (HP123) (Refer to Figure 3)	Centred on the respective exploratory location(s), the preferred remediation technology is for the excavation and removal ACM impacted material and emplacement under Buildings or Hardstandings. The resultant voids will be back filled with a material that is chemically validated as suitable for use i.e. protective of human health, controlled waters and the wider environment. Alternatively should the Site formation level allow placement of a capillary break and Marker Layer (Orange Terram or similar) over the hotspots (refer to Figure 3) and placement on 600 mm of 'clean' imported soil is acceptable.	Centred on the respective exploratory location(s) (Refer to Figure 3) each hotspot area shall be subjected to hotspot excavation as follows: Discrete shallow excavation and installation of a 100mm capillary break layer comprised >6 mm clean graded material over which a geotextile marker layer (orange terram or similar) should be placed. A minimum of 300 mm of clean site won material, overlain with 300 mm of clean imported topsoil to original ground level can then be placed. Areas that require excavation are illustrated on Figure 3. In locations where soils were impacted by asbestos and proposed ground level will be lowered, further validation sampling, following earthworks, for the presence of asbestos is required. If validation samples confirm that asbestos is still present, a hotspot excavation centred on the exceedance (ca 10 m x 10 m) will be required followed by installation of the capillary break/capping layer as detailed above. Prior to backfilling the void(s), verification testing is required to confirm the removal of impacted material has been suitably completed; This will comprise: - Collection of one sample from each sidewall of the excavation and one sample from the base. - Sidewall samples will be taken within the centre of the sidewall at a depth midway up the wall in Made Ground soil. For dimensions greater than 10 m, additional samples will be required at a rate of one sample per 10m length. - The base samples shall be taken at the centre of the excavation. - Dimension of the excavation and locations of the verification samples must be recorded including the approximate co-ordinates and elevation from surface. - An annotated photographic record showing sides and base of the excavation is required prior to infilling. Photographs should include details of the location, date and a colour chart to allow for colour balancing. - The samples will be chemically tested using an independent UKAS and MCERTS accredited laboratory and the results submitted to the Environmental Consultant for prior approval prior to backfilling the void. - If the verification testing contains contaminants concentration in excess of the remediation guideline criteria, further excavation will

RPL	Objective	Preferred Remediation Option	Actions and verification requirements
			be required to the following extent: - Excavation Base Failures – remove material to a vertical depth of 0.1 m; - Excavation Sidewall Failures – remove material to the face for horizontal depth of 0.5 m and vertically the full depth of the excavation. Upon removal of the additional material further validation testing will be conducted in accordance with the sampling regime described above. Should the additional testing contain contaminant concentrations in excess of the remediation guideline criteria, further excavation will be required as described in the bullet points above. Sidewall and base verification shall comprise Asbestos testing as detailed in Table 7-2, below. Excess soil that is generated from construction works (including any Topsoil strip) can potentially be retained and re-used beneath hardstand areas, provided that it is classified as suitable for use (Refer to Table 7-3). During the construction works this material must be chemically characterised for potential re-use on site or for offsite disposal. Typically at a rate of 1 chemical test: 500 cu.m (minimum of three samples per stockpile) and subject to the agreement of Statutory Bodies. During groundworks appropriate PPE/RPE and mitigation methods against the release of airborne asbestos fibres (including air monitoring) are recommended.
RPL2	Carbon dioxide generated from within the Made Ground	The concentrations of carbon dioxide generated from underlying Made Ground pose a potential asphyxiation risk within the offices associated with each unit. concentrations. The Site has been classified as Gas Characteristic Situation 2, in accordance with CIRIA C665. As such a gas resistance membrane is will be required within within office areas. On this basis it is recommended that a 1200 g/DPM membrane is installed in accordance with BRE212/BRE414 in office areas. These measures should be confirmed with the Local Authority Building Control Officer in advance of construction.	Details of the membrane installation and documented evidence will be included within the WSP validation and verification report to be produced on completion of all remedial works. The ground floor slab will be in a cast in-situ concrete that will be laid on a gas resistant membrane similar in properties and characteristics to Visqueen Gas Barrier™ within the office space, in accordance with the manufacturers guidance, with all joints and penetrations sealed. The actual membrane will be determined by the development contractor and approved in writing by the Local Authority prior to installation.
RPL3	Previously unidentified contamination within shallow Made Ground	There is a potential for previously unidentified contamination to be encountered during the earthworks and piling operations on Site. A WSP Engineer will be on site during the earthworks and piling operations. Should visually or olfactory impacted material be encountered, excavation will be required,	Centred on the area of previously unidentified contamination each area shall be subjected to hotspot excavation to the extent at which visual and olfactory evidence of contamination has been removed. The excavated material can be temporarily stockpiled on Site, for pre-treatment (complex sorting) and waste classification, prior to being

RPL	Objective	Preferred Remediation Option	Actions and verification requirements
		with the subsequent side walls and base of the excavation validated. WSP will agree suitable remedial approach with the Local Authority. The excavated material will be subject to complex sorting on Site under supervision and direction of WSP allowing for streams of material to be generated, comprising potentially suitable for re-use and material for disposal from site. The characterisation of material will be based on visual and olfactory evidence. Material deemed unsuitable to be retained on Site will be removed to a suitably licenced facility. Remaining material will be re-used on Site following suitable chemical analysis. The resultant voids will be backfilled with a material that is chemically validated as suitable for use i.e. protective of human health, controlled waters and the wider environment.	disposed of offsite at a suitably licenced facility or reused on site if deemed chemically suitable. The excavated material shall be stockpiled in designated bunded areas preventing the release of potentially contaminated run-off from the stockpiled material. WSP envisage there to be a total of three streams of material following the excavation and complex sorting as detailed below: 1. Contaminated – to be classified and removed from site to a suitably licenced facility: analysis will be specified by the waste hauler/disposal facility to ensure appropriate classification; 2. Potentially Contaminated – to be classified and either removed from site to a suitably licenced facility or re-used on site at suitable locations (i.e. under buildings and hardstanding) – chemical analysis for re-use will be in accordance with that detailed in Table 7-3 below, and will be tested at a rate of 1 sample per 100 m³ with a minimum of three samples collected. If the material is deemed unsuitable for re-use, it will be removed from site in accordance with the above; and 3. Considered to be Suitable for re-use – this material will be chemically tested for the chemicals of concern included in Table 7-3 below. Samples will be collected at a rate of one sample per 100 m³ and a minimum of three samples. Should the material pass the remedial criteria, it will be re-used on site under buildings and hardstanding. Should it be identified to be unsuitable, it will be classified by a designated waste hauler for removal from site. Prior to backfilling the void(s), verification testing is required to confirm the removal of impacted material has been suitably completed; This will comprise: ■ Collection of one sample from each sidewall of the excavation and one sample from the base. ■ Sidewall samples will be taken within the centre of the sidewall at a depth midway up the wall in Made Ground soil, or where the visual appearance and odour indicated the possible presence of contamination. For dimensions greater than 10 m, one sample per 10 m section is required. ■ The base samples shall be taken at the centre of the excavation or where the visual appearance and odour indicated the possible

RPL	Objective	Preferred Remediation Option	Actions and verification requirements
			presence of contamination. ■ Dimension of the excavation and locations of the verification samples must be recorded including the approximate co-ordinates and elevation from surface. ■ An annotated photographic record showing sides and base of the excavation is required prior to infilling. Photographs should include details of the location, date and a colour chart to allow for colour balancing. ■ The samples will be chemically tested using an independent UKAS and MCERTS accredited laboratory and the results submitted to the Environmental Consultant for prior approval prior to backfilling the void. ■ If the verification testing contain contaminants concentrations in excess of the remediation guideline criteria further excavation will be required to the following extent: • Excavation Base Failures – remove material to a vertical depth of 0.1 m; • Excavation Sidewall Failures – remove material to the face for horizontal depth of 0.5 m and vertically the full depth of the excavation. Upon removal of the additional material further validation testing will be conducted in accordance with the sampling regime described above. Should the additional testing contain contaminants levels in excess of the remediation guideline criteria, further excavation will be required as described in the bullet points above. Sidewall verification shall comprise testing as detailed in Table 7-3, below.
RPL4	Measures required to protect potable water supply	At this stage and on the basis that locations of service utilities are not finalised it is recommended that suitable protection should be provide to the water supply from petroleum hydrocarbons and phenol	Due to the potential placement of potable water supply pipes through soils that may contain elevated levels of hydrocarbons above the UKWIR trigger values, polyethylene pipe protection measures are required. WSP recommends in consultation with the Water Supply Company, that barrier pipes and fittings are used. The locations of the service trenches must be surveyed in and the dimensions and elevations recorded and detailed on an as built drawing.

Table 7-2 Sidewall and Base Validation Criteria & Site Won Re-use Criteria

Determinand	Concentration
Asbestos	<0.001% w/w

Table 7-3 Validation Criteria

Determinand	Concentration (mg/kg)
Arsenic	640
Boron	190,000
Cadmium	230
Chromium (VI) (Hexavalent)	35
Copper	72,000
Total Cyanide	60
Lead	2,300
Inorganic Mercury	3,600
Nickel	1,800
Selenium	13,000
Zinc	660,000
Benzo[a]anthracene	89
Benzo[b]fluoranthene	100
Benzo[k]fluoranthene	140
Benzo[ghi]perylene	650
Benzo[a]pyrene	14
Chrysene	14
Dibenz[ah]anthracene	140
Fluoranthene	23,000
Indeno[123-cd]pyrene	60
Naphthalene	200 (76)
Pyrene	54,000
Fluorene	64,000 (31)
Anthracene	520,000
Phenanthrene	22,000
Acenaphthylene	84,000 (86)
Acenaphthene	85,000 (57)
Benzene	28
Toluene	59,000 (870)
Ethylbenzene	17,000 (520)
m & p-Xylene	6,200 (580)
o-Xylene	6,900 (480)

Determinand	Concentration (mg/kg)
Aliphatic EC >5-6	3,400 (304)
Aliphatic EC >6-8	8,300 (144)
Aliphatic EC >8-10	2,100 (77)
Aliphatic EC >10-12	10,000 (34)
Aliphatic EC >12-16	61,100 (24)
Aliphatic EC >16-21	160,000
Aliphatic EC >21-35	160,000
Aromatic EC >5-7	28,000 (1217)
Aromatic EC >7-8	59,000 (869)
Aromatic EC >8-10	3,700 (613)
Aromatic EC >10-12	17,000 (364)
Aromatic EC >12-16	36,000 (169)
Aromatic EC >16-21	28,000
Aromatic EC >21-35	28,000
Asbestos	<0.001% w/w

It should be noted that (*brackets*) indicate the soil saturation limit for the associated contaminant of concern, which denotes a potential risk to human health if contamination is present as 'free phase product'. If product is not present risk to human health are considered to be acceptable with regards to hydrocarbon and organic contaminants.

Table 7-4 – Import Material Criteria

Determinand	Concentration (mg/kg)
Arsenic (C4SL)	170
Boron	10,000
Cadmium (C4SL)	880
Chromium (VI) (Hexavalent) (C4SL)	250
Copper	6,200
Total Cyanide	60
Lead (C4SL)	1,300
Inorganic Mercury	238
Nickel	130
Selenium	595
Zinc	40,000
Benzo[a]anthracene	3.7
Benzo[b]fluoranthene	7.0
Benzo[k]fluoranthene	10.0
Benzo[ghi]perylene	47
Benzo[a]pyrene	21

Determinand	Concentration (mg/kg)
Chrysene	8.8
Dibenz[ah]anthracene	0.86
Fluoranthene	970
Indeno[123-cd]pyrene	4.2
Naphthalene	1.6
Pyrene	2,300
Fluorene	1,900
Anthracene	20,000
Phenanthrene	830
Acenaphthylene	2,000
Acenaphthene	2,000
Benzene (C4SL)	230
Toluene	607
Ethylbenzene	167
m & p-Xylene	53
o-Xylene	60
Aliphatic EC >5-6	30
Aliphatic EC >6-8	73
Aliphatic EC >8-10	19
Aliphatic EC >10-12	93 (34)
Aliphatic EC >12-16	740 (24)
Aliphatic EC >16-21	45,000 (8.5)
Aliphatic EC >21-35	45,000 (8.5)
Aromatic EC >5-7	260
Aromatic EC >7-8	610
Aromatic EC >8-10	33
Aromatic EC >10-12	180
Aromatic EC >12-16	1,300 (168)
Aromatic EC >16-21	1,300
Aromatic EC >21-35	1,300
Asbestos	<0.001% w/w

7.1 Previously unidentified contamination (RPL3)

During earthworks and piling operations, WSP require a watching brief by a competent environmental consultant. Should visual signs or olfactory signs of contamination be identified then the following is required:

- Stop works in the location of identified gross contamination;
- Inform the Site Manager;
- Environmental consultant to inform Local Planning Authority Contaminated Land Officer.
- Excavate the impacted area until impacted material is removed.
- The excavated material can be temporarily stockpiled on Site, for pre-treatment and waste classification, prior to being disposed of offsite at a suitably licenced facility in accordance with RPL3 in **Table 7-1** above.
- Verification of the excavation is required as per specification described, above and in accordance with **Table 7-3**.

As general Site Management good practice, WSP require that prior to earthworks operatives are given a tool box talk on potential contaminated land risks in particular the possibility of encountering Asbestos Containing Material (ACM).

WSP note that if suspected ACM is identified then the following is required:

- Stop works in the vicinity of the suspected location;
- Inform Site Manager;
- Environmental consultant to inform Local Planning Authority Contaminated Land Officer;
- Operatives to be provided with appropriate PPE;
- Damp and cover the location to prevent release of asbestos fibres;
- Fence off the area to prevent tracking of fibres across the Site by vehicle / people movements;
- Collection of soil sample for asbestos quantification testing;
- If the sample is negative for asbestos (i.e. non-detect or <0.001%) no further works are required;
- If the sample records asbestos at >0.001% or is in an area of soft landscaping then the material must be excavated in accordance with above; and
- If the sample records asbestos at <0.1% and is below an area of hardstand or building then the material can remain, provided that a woven geotextile membrane (terram hi viz) and 200 mm of clean validated material is placed over the soil to minimise the spread / release of asbestos fibres during construction phase; or excavated to a temporary covered stockpile for placement below a hardstand area at a later time. If ACMs are identified and the Contractor opts to allow the material to remain in place (after providing cover layer) the extent must be surveyed and recorded on an as built drawing and retained in the Health and Safety File.

7.2 Waste Management

The Contractor undertaking the remediation works is responsible for compliance with waste management legislation where issues relating to waste arise as a result of the works.

A materials management plan (MMP) should be considered if the Site become a donor or receiving Site under the CL:AIRE Code of Practice.

The Contractor should provide a works materials management statement that sets out the circumstances and criteria for which materials are to be classified as waste or non-wastes.

The Contractor is required to provide method statements illustrating how compliance with waste management legislation is to be achieved for those materials classified as waste, to include but not limited to:

-
- Use of imported material;
 - Criteria for assessing of the suitability of imported materials;
 - Management of material that arises during the works and is classified as waste;
 - Waste streams are appropriately classified prior to offsite disposal.
 - Audit process for the selection of waste management contractors to include the collection and assessment of licences, permits and registrations; and
 - Audit process and record keeping.

7.3 Environmental Monitoring and Control Measures

As part of remediation works at the Site there will be a requirement for environmental controls and monitoring. In particular controls will be most relevant in areas that include soil stockpiling and processing.

Typical considerations will focus on groundwater, air, noise and vibration and odour. Information on the methodologies and controls will be provided by the Contractor and agreed with the Local Authority.

7.4 Other Import Material for General Land Raise

Any material required to raise the level of the Site, outside of the landscaped areas as detailed in RPL3, and is to be placed under buildings and hardstanding material will need to be tested at a rate of one sample per 500 m³, with a minimum of three per source. The chemical acceptance criteria is provided in **Table 7-4**.

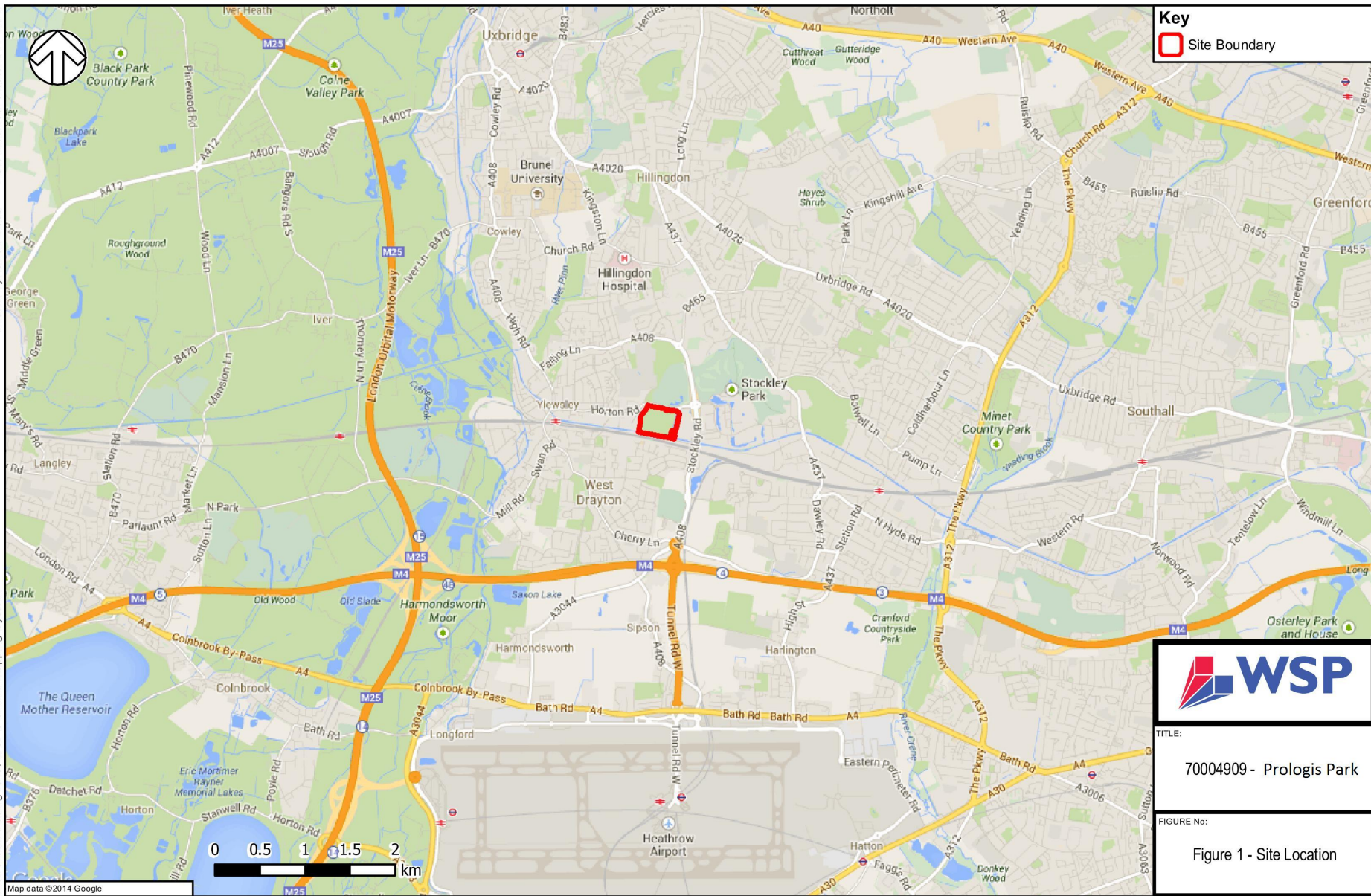
8 Verification Report

All relevant information shall be collected during the remediation works and an independent validation report compiled on completion. The validation report shall take account of the recommendations in CLR11 and comprise as a minimum:

- A summary of the information contained in the risk assessment reports along with the agreed redevelopment strategy and objectives;
- Details of all parties involved in the works;
- Laboratory validation test certificates;
- Details and quantities of excavated soils and soils re-used on site or disposed of off -site;
- Details of the validation data for imported soils if used on-site (at least three sets of analysis per source plus additional samples one every 100 m³ for areas of soft landscaping and one every 500 m³ under hardstanding;
- Records of all earthworks, excavations and sorting including as built drawings, photographs, quantities of materials; and
- Waste classification and management documentation.

It is envisaged that the site Health and Safety File will include all information pertaining to the areas affected by ground contamination.

Figures

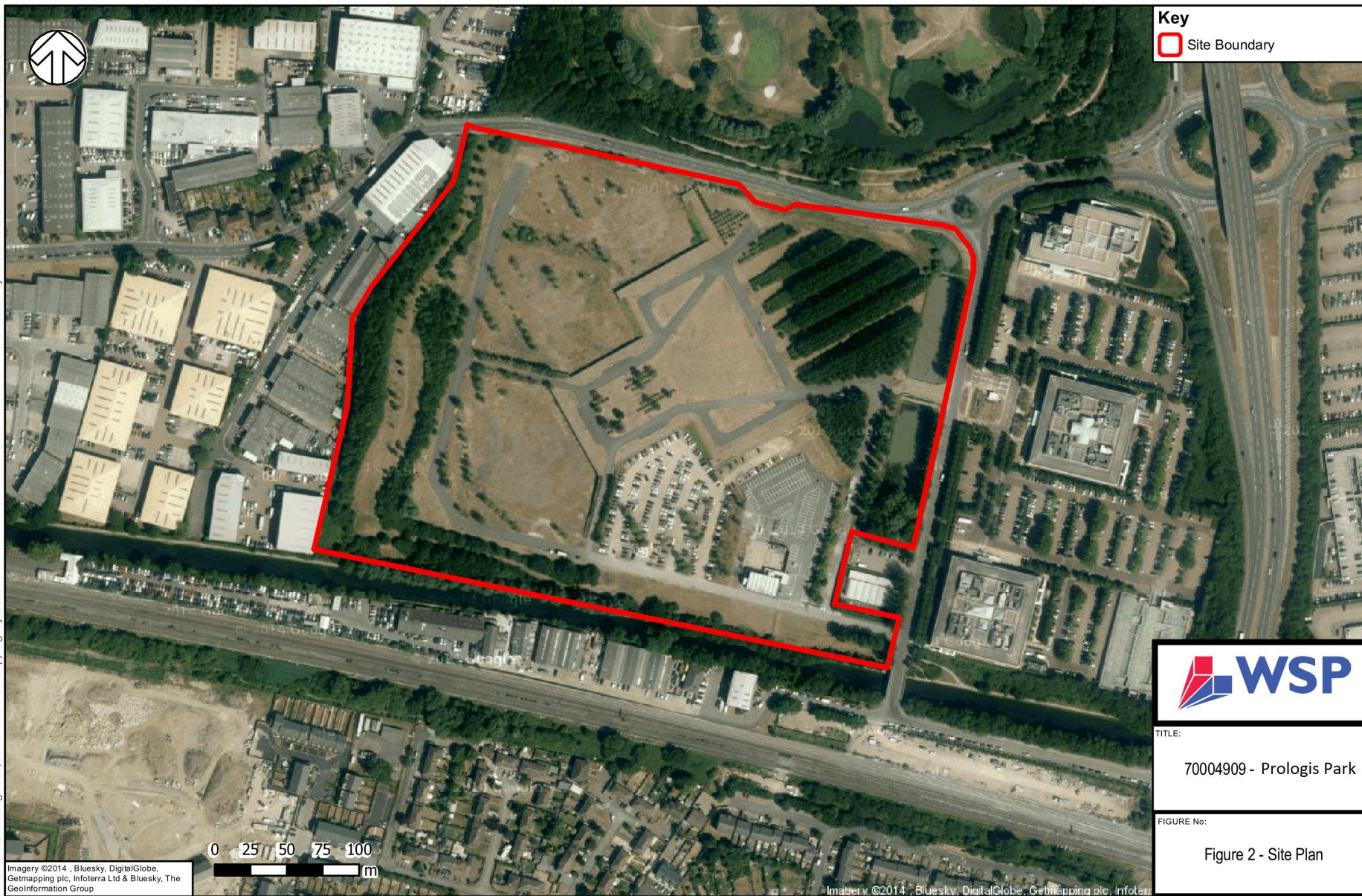


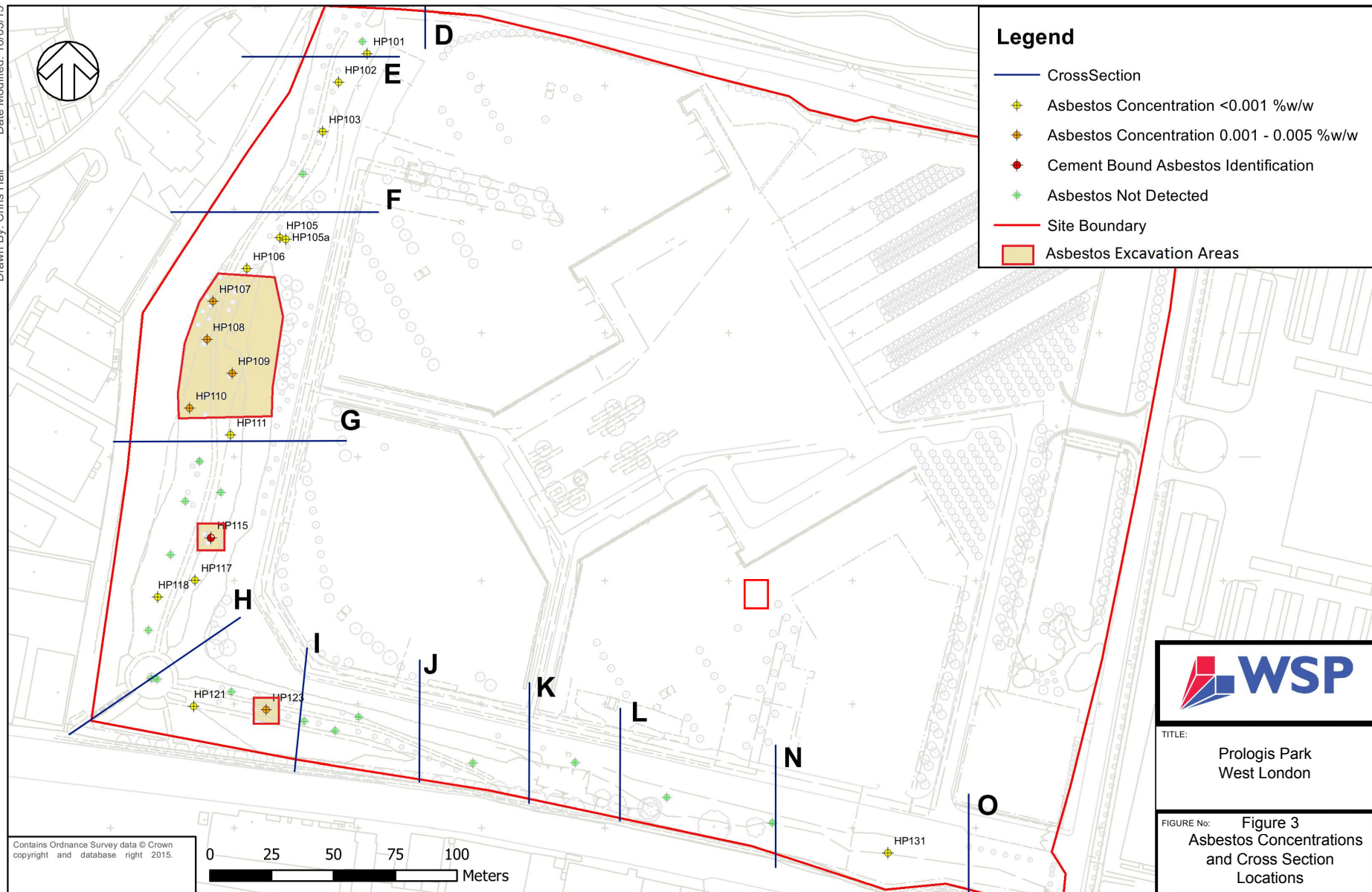
Key
[Red Rectangle] Site Boundary



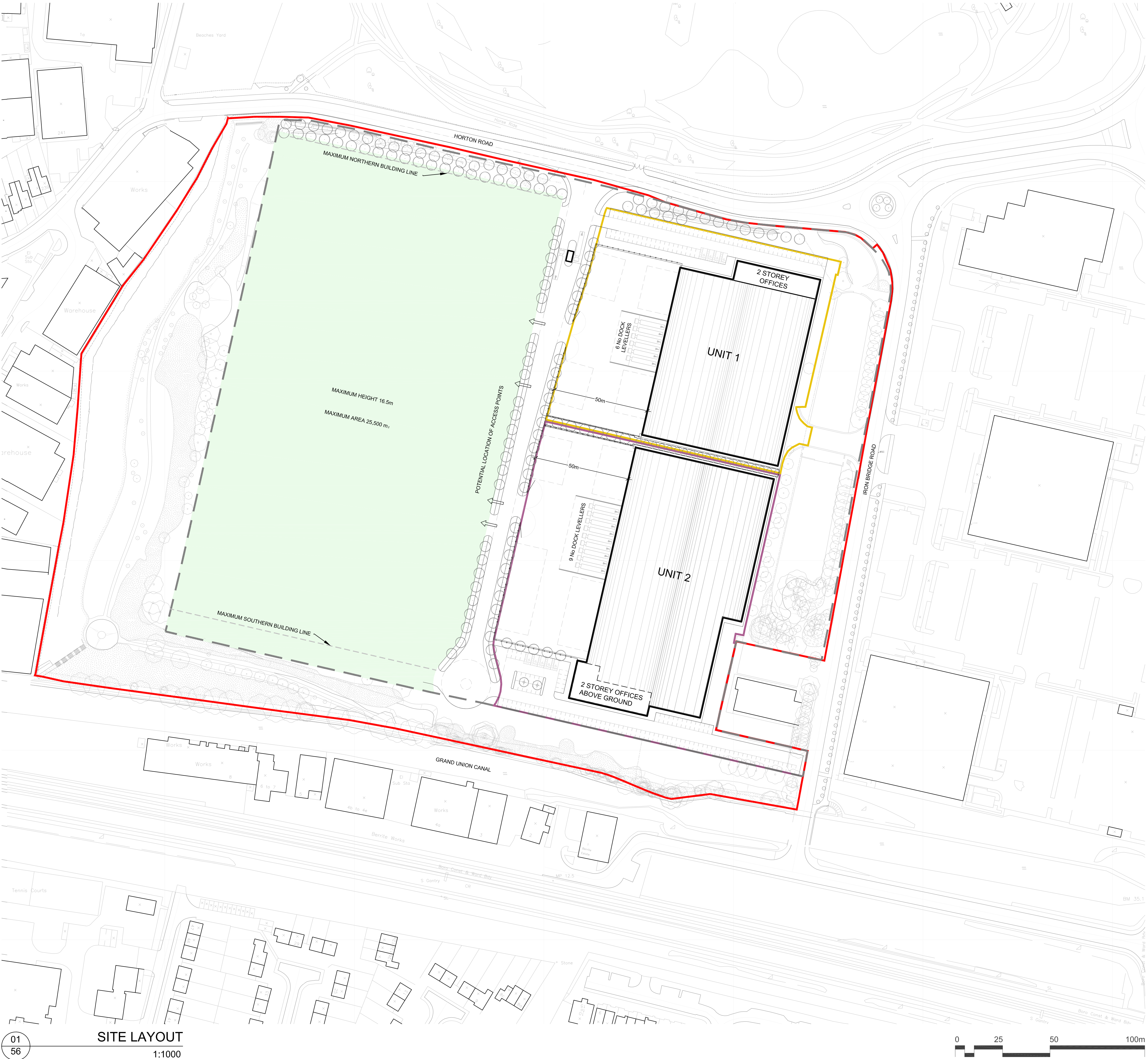
TITLE:
70004909 - Prologis Park

FIGURE No:
Figure 1 - Site Location





Appendix A Masterplan



NOTES:

SUBJECT TO STATUTORY CONSENTS

SUBJECT TO SURVEY

BASED ON OS MAP REPRODUCED BY PERMISSION OF CONTROLLER OF HM STATIONARY OFFICE (c) CROWN COPYRIGHT

COPYRIGHT RESERVED

DO NOT SCALE THIS DRAWING

DO NOT USE ELECTRONIC VERSIONS OF THIS DRAWING TO DETERMINE DIMENSIONS UNLESS SPECIFICALLY AUTHORISED BY MICHAEL SPARKS ASSOCIATES

IF USING AN ELECTRONIC VERSION OF THIS DRAWING FIGURED DIMENSIONS TAKE PRECEDENCE AND NOTIFY MICHAEL SPARKS ASSOCIATES OF ANY DISCREPANCIES

REV	DATE	NOTE	DRAW	CHK



MICHAEL SPARKS ASSOCIATES

CHARTERED ARCHITECTS

11 PLATO PLACE
STUDIOS ROAD
LONDON SW6 4TU

TELEPHONE 020 7736 6162
FAX 020 7736 3896
www.msa-architects.co.uk



PROLOGIS

TITLE

PHASE 3, STOCKLEY PARK

DRAWING

SITE LAYOUT AND PARAMETERS PLAN

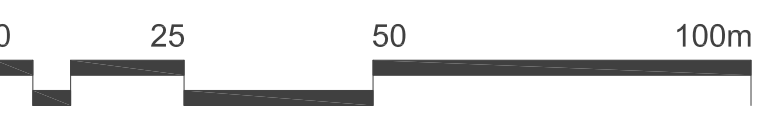
CLIENT

PROLOGIS UK LTD

DATE	SCALE	DRAWN
JAN 2015	1:1000	PF
STATUS		CHECKED
PLANNING		MS/GZ

DRAWING NUMBER

27122 / PL / 056



Appendix B Screening Criteria

The Regulatory Framework for our Assessment

Our assessment is made within the framework of the Contaminated Land Regime defined by Part 2A of the Environmental Protection Act and the Contaminated Land Statutory Guidance 2012.

We have considered the contaminated land guidance documents issued by the Department for Environment, Food and Rural Affairs (DEFRA) including Model Procedures for the Management of Land Contamination (CLR11) (Environment Agency 2004a).

Our method is to create a clear conceptual model of the potential Pollutant Linkages present on site, consider the Sources (potential contaminants on site) which may cause harm, via Pathways, to Receptors such as human health (e.g. that of site users), the water environment (groundwater, surface water) and the built environment (buildings, services). Contaminated Land has a precise definition, and does not include all land which contains contaminants, but only land where there is a Pollutant Linkage causing (or giving rise to a significant risk of) a degree of harm.

Our approach to the assessment of risks to Human Health is consistent with that established in CLR11. This establishes a tiered approach including:

- Preliminary Risk Assessment (e.g. the establishment of potential pollutant linkages) – normally through desk based work;
- Generic Quantitative Risk Assessment (GQRA) (e.g. the comparison of contaminant concentrations against Soil Guideline Values (SGV) or other Generic Assessment Criteria (GAC)); and
- Detailed Quantitative Risk Assessment (DQRA) (e.g. the comparison of contaminant concentrations against site specific assessment criteria).

Our approach to Generic Quantitative Risk Assessment (GQRA) is described in outline in the following section.

In addition to the Contaminated Land Regime, where appropriate, we have considered

- The Environmental Damage Regulations (2009). These implement the European Environmental Liability Directive and provide that, for certain activities, where there is an imminent risk of environmental damage, steps must be taken to prevent such damage, and if environmental damage has already occurred, the operator of the activity must prevent further damage.
- Common Law Liability. This remains an important aspect of contaminated land law, particularly for third parties harmed by, or suffering loss as a result of, contaminated land. Through Nuisance a person may be liable if he owns or occupies land and behaves in a way so as to cause foreseeable injury, loss or damage by creating a nuisance, for example by allowing contamination to migrate off-site either over a period of time or as a one-off event. By Negligence, where the owner of contaminated land owes a duty of care (to a claimant) which was breached. In Trespass where the contamination on a defendant's land has directly interfered with the property of a claimant.

Our Approach to GQRA

Once we have an initial understanding of the site and the potential pollutant linkages in place we plan our investigation, soil sampling regime and analytical suites. Our plan is informed by documentation such as

- The available desk study/preliminary risk assessment reports available for the site;
- CLR 8 'Priority Contaminants for the Assessment of Land' (Environment Agency 2002a); and,
- The Department of the Environment's Industry Profiles (DoE 1995-95).

In order to undertake a GQRA, contaminant concentrations need to be compared to appropriate generic assessment criteria. Current UK industry practice is to use, as first preference, UK Soil Guideline Values (SGV)s which are generic assessment criteria published by the Environment Agency and derived using the Contaminated Land Exposure Assessment model (CLEA).

The CLEA model provides an approach for the assessment of chronic risks to human health from concentrations of a substance within soil; where appropriate. However, the SGVs published to date are limited to only a small number of contaminants. Consequently, where published SGV do not exist, other GAC can be used including:

- GAC prepared in accordance with the CLEA V1.06 model by authoritative bodies (e.g. Chartered Institute of Environmental Health (CIEH), Environment Industries Commission (EIC)); or in their absence
- WSP in-house GAC prepared in accordance with the CLEA V1.06 model and associated documents.

The approach adopted by WSP has been to generate GAC for chronic risks to human health using CLEA V1.06. In generating GAC, input parameters consistent with Environment Agency publications have been adopted by WSP. In generating GAC, the default CLEA assumptions have been applied to a range of likely human health exposure models and associated critical age receptor groups including:

- Residential with Plant Uptake;
- Residential without Plant Uptake;
- Allotments;
- Parks;
- Open Spaces; and,
- Commercial/Industrial.

Cyanides

The primary risk to human receptors from free cyanide in soils is an acute risk (i.e. a single dose could have a lethal affect as opposed to adverse effects from cumulative intake (chronic affect)). There is no current UK guidance available for calculating acute risks from free cyanide, therefore an in-house methodology has been used to derive an acute GAC of 60 mg/kg for all exposure scenarios.

Volatile Hydrocarbons from Groundwater and Impacts to Human Health.

The CLEA model does not explicitly consider the potential for chronic impact to Human Health from indoor inhalation of concentrations of volatile vapours from dissolved phase contamination. The potential exists for this to be an important exposure route for a limited number of highly volatile contaminants. GAC have been calculated for volatile contaminants for volatilisation from groundwater using an in-house implementation of the Johnson and Ettinger model (WSP In-house Groundwater Model V1.1) which has been adapted to account for a dissolved phase source through consideration of (a) partitioning from groundwater to soil vapour, and, (b) transport through the capillary zone.

Generic Quantitative Risk Assessment - Controlled Waters

Our approach to the assessment of plausible pollutant linkages with respect to the pollution of Controlled Waters is consistent with UK guidance. The guidance identifies that for the pollution of the water environment to occur; poisonous, noxious, polluting or solid waste matter must be entering such waters or must be considered more likely than not to enter the water environment in the future. The assessment of whether the pollution of the water environment is likely to occur in the future requires consideration of those contaminants at source, which are present in a mobile form, at such a concentration that they will reach a receptor at concentrations considered to be poisonous, noxious, polluting or solid waste matter.

Our adopted approach for GQRA assessment therefore typically comprises the following:

- Consideration of soil concentrations of organic substances in the context of soil saturation to assess the potential for migration under gravity;
- Comparison of soil leachate/pore water concentrations against appropriate GAC; and
- Comparison of groundwater concentrations against appropriate GAC.

This approach is equivalent to Tier 1 / Level 1 Assessment as undertaken using ConSim (2009) / Environment Agency Remedial Targets Methodology V3.1 (2006).

Effectively, for the majority of sites, contaminant concentrations are compared to both drinking water standards and environmental quality standards to identify the need for further consideration/DQRA.

Further Work

Where a GAC is exceeded further work and/or remediation is normally required. For moderate exceedances further work may include progression to a Detailed Quantitative Risk Assessment (DQRA) which is likely to require further data collection. The outcome of the DQRA may be that the risk is not significant or, if the risk is identified as being significant, the generation of site-specific remedial targets.

Where significant exceedances of GAC are identified or there is evidence of potential acute risks remedial measures may be immediately required.

Ground Gas

Gas results have been assessed with regard to Assessing Risks Posed by Hazardous Gases to Buildings, CIRIA Report C665, 2007 (CIRIA C665) and, where a residential end use is being considered, Guidance on Evaluation of Development Proposals on Sites where Methane and Carbon Dioxide are Present, Edition 4, NHBC, 2007 (NHBC 2007).

The method in CIRIA C665 uses both gas concentrations and borehole flow rates to define a characteristic situation for a site based on the gas screening value for methane and carbon dioxide. Gas screening value = borehole flow rate (litres of gas per hour) x gas concentration (%). The calculation is carried out for both methane and carbon dioxide and the worse-case value adopted.

If necessary, more detailed information on our approach to risk assessment can be provided on request.

Appendix C

Limitations for WSP Land Restoration and Ground Engineering Division

General

WSP has prepared this report solely for the use of the Client and those parties with whom a warranty agreement has been executed, or with whom an assignment has been agreed and outlined in the body of the report. Unless explicitly agreed otherwise, in writing, this report has been prepared under WSP Standard Terms and Conditions, as included within our proposal to the Client.

Project specific appointment documents may be agreed on a project by project basis, at our discretion. A charge may be levied for both the time to review and finalise appointments documents and also for associated changes to the appointment terms. WSP reserve the right to amend the fee should any changes to the appointment terms create an increase risk to WSP.

The report needs to be considered in the light of the WSP proposal and associated limitations of scope. The report needs to be read in full and isolated sections cannot be used without full reference to other elements of the report. The report is only valid for its originally intended purpose as set out in either our report or the proposal.

Detailed Quantitative Risk Assessments and Remedial Strategy Reports

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

The outputs of the Detailed Quantitative Risk Assessments are based upon WSP manipulation of standard risk assessment models. Models are simulations based on the available data set and should not be used as predictions.

Where a remediation strategy is proposed, this is based on our interpretation of the risk assessment criteria and is specific to a particular location and a particular intended land use and configuration / layout. Prior to adoption they will need discussing and agreeing with the Regulatory Authorities prior to adoption on site. The regulatory discussion and engagement process may result in an alternative interpretation being determined and agreed. The process and timescales associated with the Regulatory Authority engagement are not within the control of WSP. All costs and programmes presented as a result of this process should be validated by a quantity surveyor and should be presumed to be indicative.

Monitoring (including Remediation Monitoring reports)

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

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

Appendix D

Remediation Techniques

Technique 1: Excavation and Removal to Licensed Facility (Landfill or Soil Treatment Facility)

Wholesale excavation of contaminated material and removal to landfill is a quick method of removing a contaminant source (and liability), provided that sidewall and base validation testing is undertaken to confirm the complete removal of soil source.

However, this method can be prohibitively expensive in terms of road haulage costs and landfill tax payments if disposal at landfill.

Technique 2: Ex-Situ Bioremediation (Bio-piles)

Bioremediation is an effect treatment method for organic contaminants by the use of micro-biological activity to degrade contaminants. Natural processes can be enhanced by controlling inputs such as nutrient, moisture, oxygen and temperature.

Bio-piling is an ex-situ method whereby excavated material is placed into piles or windrows and hydrocarbon contamination is reduced by stimulating aerobic microbial activity through a variety of methods including forced aeration; addition of cultured organisms; and / or composting techniques. Lighter end organic compounds are removed via evaporation and heavier end contaminants are broken down through microbial respiration.

The advantages of bio-piling is that it is easy to design; well understood; relatively inexpensive; and can be effectively treatment for organic contaminants with slow biodegradation rates.

The disadvantages with bio-piling is that the technique is ineffective for inorganic contaminants; difficult to achieve 100% contaminant concentration reductions; difficult to achieve low contaminant concentrations i.e. <0.1 ppm; concentrations >2,500 ppm may inhibit microbial activity; volatile contaminants tend to evaporate rather than degrade; requires a large area; time scale may be restrictive (6 months to 2 years); soil chemistry and structure may restrict application i.e. high clay content can reduce aeration, high/low pH may restrict microbial activity; control of leachate; and the technique requires active management.

Technique 3: In-situ Bioremediation (enhanced aerobic/anaerobic bioremediation)

These are in situ treatment methods through the addition of oxygen (electron acceptor) or hydrogen containing compounds to soils (and or groundwater) to increase the biological activity of microorganisms present in soils and groundwater. The addition of cultured organisms can also enhance and accelerate the process.

Enhanced aerobic treatments can include biosparging/ bioventing/ addition of proprietary oxygen releasing compounds.

Enhanced anaerobic treatments can include injection into the unsaturated zone with proprietary hydrogen releasing compounds such as lactose, lactic acid, lactates, molasses and dairy bi-products.

The advantages of enhanced aerobic/anaerobic bioremediation include: increased degradation rates of natural processes; simple technology; no long term operational costs and maintenance; minimal site disturbance; and can be combined as a polishing step with other methods, such as in situ chemical oxidation.

The disadvantages are similar to that of biopiles, but in particular it is not suited for inorganic contamination; the techniques are difficult to validate; it may alter the geochemistry of the soils / aquifer; the oxygen / hydrogen donors may be lost to processes that do not promote hydrocarbon degradation; reduced efficiency; slow remediation process; and can be expensive over large areas.

Technique 4: Soil Washing

Soil washing is a volume reduction/waste minimization treatment process either via physical processes, whereby contaminant particles (usually sorbed to clay fines and silts) are separated from the bulk soil fractions, or via chemical processes where the contaminants are removed from the soil using aqueous chemicals.

The advantages of soil washing include: ability to treat inorganic and organic contaminated materials; reduces the volume of material required to be disposed of offsite to landfill; cleaned material can be reused as inert backfill; an established technology; is a relatively simple technology involving few processes; and inexpensive for larger volumes.

The disadvantages are that the cost of treatment is weighed against the disposal cost, if the recovery of 'clean' material is low then the technology is expensive; it is not suitable for clay soils; may be difficult to achieve high contaminant removal efficiencies for organic contaminants; and difficult to treat low contaminant concentrations i.e. <0.1 ppm.

Technique 5: Solidification / Stabilisation

Solidification/stabilisation (S/S) physically binds or encloses contaminants within a stabilised mass (solidification), or chemical reactions are induced between a stabilising agent and contaminants to reduce their mobility (stabilisation). Unlike other remedial technologies S/S seeks to trap or immobilise contaminants within the soil matrix instead of removing or destroying them through chemical or physical treatment.

S/S techniques can be used in-situ through injection and mixing tools such as augers, or ex-situ whereby contaminated soils are excavated and mixed above ground.

The advantage of S/S is that the method is relatively quick and low cost. The disadvantages with S/S is that there is disagreement over whether it is appropriate to use against organic contaminants; and the contaminant is not removed or destroyed as such with time the treated site may degrade and re-release the contaminants.

Technique 6: Thermal Desorption

This technology uses heat to remove contaminants from soils. It is most commonly used to treat organic contaminants, but can also be used to remove inorganic contaminants. Excavated soil is placed in a 'desorber' which heats the soil to a temperature high enough to transform contaminants to the gas phase, where they are collected and then removed. A pre-treatment stage may be required to remove large obstructions, to crush the materials or to reduce moisture content.

The advantages of thermal desorption are that high volumes of impacted material can be treated; it can be a relatively quick method; thermal desorption is suitable for material impacted by contaminants that do not readily bio-degrade i.e. pesticides and herbicides; and the treatment efficiency is high.

The disadvantage of thermal desorption is that it can be a relatively high cost treatment method requiring large energy inputs, especially if the excavated material is wet; high set up costs; soil organic matter is removed, as such the treated material may require additional inputs of nutrients post remediation; and a complicated technology requiring careful monitoring / modelling of flue gas chemistry and dispersion patterns.

Appendix E

Table E-1 Evaluation of Remediation Technologies for Small Scale Shallow Impacted Soils

Evaluation Criteria	Remediation Technology					
	1	2	3	4	5	6
Relevant Pollutant Linkage	1,3	3	3	3	1,3	3
Effectiveness in achieving remediation (max 10)	10	6	4	7	6	5
Cost (max 10)	4	6	4	3	6	1
Environmental impacts (max 10)	6	8	6	5	5	1
Sustainability (max 10)	5	7	7	6	6	3
Durability over time (max 10)	10	7	6	6	2	10
Stakeholder requirements (max 10)	9	4	3	4	4	3
Operational requirements (max 10)	9	5	5	5	4	2
Commercial availability (max 10)	10	9	7	8	8	6
Track record of use (max 10)	10	10	7	8	4	6
Timescale (max 10)	10	4	3	6	6	6
Practicability of verification (max 10)	10	4	4	7	7	8
Long term monitoring and maintenance (max 10)	10	5	5	8	8	9
Score (max 120)	103	75	61	73	66	60

Scores based on 10 = positive impact to 1 = negative impact

RPL1: ACM Soils impacted area (Hotspots 1 -3)

RPL3: Previously unidentified contamination