London City Airport
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City Airport Development Programme (CADP1)

Condition 39: Contamination

RPS

March 2018

CONTENTS

EXECUTIVE SUMMARY

This report has been prepared to provide information in support of the discharge of Part a) and Part b) of Condition 39 of the planning permission for the City Airport Development Programme (CADP) 1. A number of site investigations have previously been undertaken across the CADP site and the wider Airport site. Information obtained as part of these investigations is summarised in the report and utilised to satisfy Part a) of the Condition. This information has also been used to inform the remediation strategy, required under Part b) of the Condition.

The results of the previous landside investigations identified lead and asbestos within Made Ground sampled from beneath landside areas of CADP1. It is understood that soft landscaping is proposed to be included as part of CADP1, within the service yard associated with the WTE and the new forecourt area. It is therefore recommended that, as a minimum, a 300mm validated clean topsoil cover layer should be installed in these areas of soft landscaping. Volatile contaminants were not detected at significant concentrations within soils or groundwater sampled from beneath landside areas. The vapour inhalation pathway is therefore not considered to represent a significant risk to on or off-site human health receptors. Localised elevated concentrations of PAHs and a very marginally elevated concentration of PCBs were recorded within samples of dock sediment collected as part of the 2016 Concept site investigation. It was considered by Concept that the localised exceedances were not considered to represent a potential risk to human health receptors, given that the sediment was below approximately 11.50m of water and potential pathways would therefore not be active. Based on the available information, the potential risk to human health receptors from potential contaminants of concern sourced from the site is considered to be ***LOW****.*

As part of the 2016 Delta-Simons investigation, asbestos was identified in three samples of Made Ground, collected from airside areas of CADP1. Within the 2016 Concept Geotechnical Interpretative Report, it was considered that as these samples were collected from below concrete service roads and taxiways they were therefore currently not considered to pose a risk to site users.

Arsenic, copper, selenium, cyanide, speciated total petroleum hydrocarbons (TPH CWG) and speciated polycyclic aromatic hydrocarbons (PAH) were recorded at concentrations generally only marginally in excess of available AC, within groundwater samples collected from beneath the landside area of the site. All of these exceedances were related to UK DWS screening criteria, which are considered overly conservative, given the limited resource potential of the Secondary and Principal Aquifers in the vicinity of the site.

As part of the 2016 Concept investigation, elevated concentrations of hydrocarbons (including speciated PAH and TPH) and potentially phenols (when compared to UK Drinking Water Standards (DWS)) were recorded within leachate samples collected from beneath KGV Dock. Localised exceedances of arsenic were also identified when compared to Environmental Quality Standards (EQS) values. The risks to controlled waters from contamination identified on site were considered to be low. Within the 2016 Concept

report, reference was made the 2016 Delta-Simons investigation, in which three groundwater samples were collected. Concept screened the results and it was reported that marginally elevated concentrations of copper, lead and speciated PAHs were recorded and a significantly elevated concentration of zinc, when compared to EQS values. It was considered that due to the site setting and general poor quality of groundwater (given the long history of industrial use), the area was considered to represent a low risk to controlled waters.

The nearest surface water receptors to the site are the King George V (KGV) and Royal Albert Docks. These feed into the River Thames, which, due to its large dilution potential, is not considered to be at significant risk from the relatively minor concentrations of contaminants of concern within groundwater samples collected from beneath the site. On the basis of the above, the potential for concentrations of contaminants of concern sourced from the site to pose a potentially significant risk to groundwater receptors is considered to be ***LOW****.*

An outline remediation strategy has been prepared for the site, based on the findings of the previous intrusive investigations undertaken across CADP1. The proposed remedial measures to be undertaken at the site, include the following:

- *Installation of ground gas protection measures commensurate with Characteristic Situation 2 (CS2), to be installed within buildings constructed as part of the development. The final design will be confirmed with London Borough of Newham;*
- *Elevated concentrations of hydrocarbon compounds were recorded within samples collected from shallow soils on site. Requirements for buried utilities will be discussed with services providers before the development stage;*
- *Construction workers may be exposed to contaminated soils and groundwater during works. Suitable measures to protect construction workers are envisaged to include clean/dirty working practices, provision of appropriate personal protection equipment (PPE) as well as explanations of the potential risks;*
- *Asbestos has been recorded within three samples of Made Ground collected from two boreholes advanced across landside areas of CADP1 as part of the 2014 RPS site investigation. In addition, asbestos was identified in three samples of Made Ground collected as part of the 2016 Delta-Simons airside investigation of the taxiways. A formal Asbestos Management Plan will be implemented prior to work commencing on site. Should significant quantities of asbestos be detected in soils during any site redevelopment, a specialist contractor will be approached to advise on removal and disposal;*
- *Should any soils require off-site disposal as part of the redevelopment, all surplus materials will be transferred to appropriately licensed waste management facilities by registered waste carriers under the relevant Duty of Care. It will be ensured that waste is stored and transported appropriately and securely; that waste is only transported and handled be those that are authorised to do so; and that all relevant documentation is completed, including waste transfer notes;*

- *Soft landscaping is proposed to be included as part of CADP1. Therefore a validated clean topsoil cover layer of at least 300mm will be installed in areas of soft landscaping; and*
- *A watching brief will be carried out during construction for previously unidentified contamination.*

A Validation Report will be issued upon completion of CADP1. This will be produced in-line with current best practice and include a photographic record of all works undertaken.

A Piling Risk Assessment Report relating to piling in KGV Dock was undertaken by TPS in January 2018 (a copy of this is provided as Appendix F). The report sets out the proposed method of piling as a bored pile with a permanent steel casing ('Vibrodriver Casing and Rotary Bore'). It was stated that alternatively, driven hollow steel piles could be used. However, as rotary bored piles in permanent steel casing had been carried out successfully at the airport during previous developments, these were assessed to be the most practicable piling method. It was concluded that both proposed methods provide a permanent steel casing which will protect the underlying aquifers by preventing pollutants from the dock silt and/or dock water entering the natural ground or underlying aquifers. Overall, with the proposed methods of piling and the implementation of recommended mitigation measures, the risk to controlled waters and other vulnerable receptors from the contamination identified in the dock sediment was considered to be low and no further remedial measures were considered necessary.

A Piling Risk Assessment for the Western Energy Centre (WEC) and Western Terminal Extension (WTE) was undertaken by Atkins in March 2017. A Piling Risk Assessment for the Eastern Energy Centre and Multi Storey Car Park was also undertaken by Atkins in December 2017 (copies of these are provided as Appendix G). Based on the available ground investigation data and the proposed piling methodology (continuous flight auger (CFA) or rotary bored with temporary casing), the reports concluded that there was a low risk to controlled waters receptors.

1 INTRODUCTION

1.1 Preamble

1.1.1 The City Airport Development Programme (CADP) 1 planning application (ref: 13/01228/FUL) was granted planning permission by the Secretaries of State for Communities and Local Government and Transport in July 2016 following an appeal and public inquiry which was held in March/April 2016. Condition 39 requires that:

"a) Prior to the Commencement of the relevant Phase, an investigation into ground conditions of that Phase shall be undertaken in accordance with the Model Procedures for the Management of Land Contamination, Environment Agency, Contaminated Land Report 11.

b) The report of the investigation together with a detailed remediation strategy for dealing with any identified contamination in respect of that Phase shall be submitted to the Local Planning Authority for approval in writing.

c) Upon Commencement of the Phase the approved remediation strategy for that Phase shall be implemented.

d) If, during the Development of a Phase, contamination not previously identified is found to be present within that Phase then no further Development in the areas where contamination is identified shall be carried out until a further remediation strategy has been submitted to the Local Planning Authority for approval in writing, detailing how this unsuspected contamination shall be dealt with.

e) The further remediation strategy shall be implemented as approved.

f) As soon as reasonably practicable, and before the occupation of any remediated area forming part of a Phase, a validation report shall be submitted to the Local Planning Authority for approval in writing, stating what works were undertaken and that the remedial scheme was completed in accordance with the approved remediation strategy for that Phase."

1.1.2 The Airport submitted a Construction Phasing Plan to LBN pursuant to Condition 4 of the CADP1 permission in February 2017. It was proposed to build out CADP1 as a single uninterrupted period of construction over 5 years split into two distinct phases. Consistent with terminology used in the UES, the two phases were referred to as the 'Interim Works' and the 'Completed Works' – each delivering different parts of the CADP infrastructure. The Interim Works would be delivered first and would be immediately followed by the Completed Works. This Construction Phasing Plan was approved by LBN in March 2017 (ref. 17/00500/AOD) and the details pursuant to Part a) of Condition 39 for the 'Interim Works' were also approved at the same time (ref. 17/00975/AOD).

1.1.3 Ahead of the commencement of construction of CADP1, the Airport's Delivery Partner have identified a number of programme efficiencies and improvements to the 5 year build which would reduce the

duration of the construction programme by 14 months to 3 years and 10 months and deliver the full CADP1 infrastructure in an accelerated single phase (*2017 Accelerated Construction Phasing Plan*). The new 2017 Accelerated Construction Plan has been submitted to London Borough of Newham pursuant to Condition 4 under separate cover.

1.1.4 This submission seeks approval of details pursuant to Part a) of Condition 39 for the entire approved CADP1 infrastructure to be delivered by the new 2017 Accelerated Construction Phasing Plan. A number of site investigations have previously been undertaken across the CADP site and the wider Airport site. Information obtained as part of these investigations will be utilised to satisfy Part a) of Condition 39. This information will also be used to inform the remediation strategy, required under Part b) of Condition 39.

1.1.5 At the request of LBN Officers, new text added to the previously approved details (17/00975/AOD) has been distinguished in blue text in this document.

1.1.6 A draft version of this submission has been discussed and agreed with the Environment Agency (EA). The key messages of the report are largely consistent with those of the previous submission; however the opportunity has been taken to update the assessment and recommendations based on more recent site investigation works and to cover a wider area.

1.2 Objectives

1.2.1 The principal objectives of this assessment were as follows:

- To outline the existing ground conditions beneath CADP1 and to present an environmental risk assessment in support of the discharge of Part a) of Condition 39 of the planning permission; and
- To provide an outline remediation strategy for CADP1 in support of the discharge of Part b) of Condition 39 of the planning permission, based on the findings of the environmental risk assessment.

1.3 Legislation and Guidance

1.3.1 This report has been produced in general accordance with:

- Contaminated Land (England) Regulations 2006 (as amended);
- DEFRA Environmental Protection Act 1990: Part 2A - Contaminated Land Statutory Guidance (2012);
- DEFRA and Environment Agency (2004) Contaminated Land Report 11 (CLR 11): Model Procedures for the Management of Land Contamination;
- National Planning Policy Framework (NPPF) (2012);

- British Standard requirements for the 'Investigation of potentially contaminated sites - Code of practice' (ref. BS10175:2011+A1:2013);
- British Standard requirements for the 'Code of practice for ground investigations' (ref. BS5930:2015);
- CIRIA Document C665 - Assessing risks posed by hazardous ground gases to buildings; and
- British Standard requirements for the *'Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings'* (ref. BS8485:2015).

1.3.2 Where appropriate, consideration has also been given to the following:

- The potential for environmental liabilities to occur under other associated regimes, for example the *Water Resources Act (1991)* and the *Environmental Damage Regulations (2009)*; and
- Key constraints on site redevelopment.

Details of the limitations of this type of assessment are described in Appendix A.

1.4 Site Location and CADP1 Description

1.4.1 The wider Airport site is located within the administrative area of London Borough of Newham (LBN). It is roughly rectangular in shape. The site is located in the Royal Docks, within King George V (KGV) Dock, located between the runway and the southern boundary of the Airport. The Royal Albert Dock forms the Airport's northern boundary.

1.4.2 Of those elements of CADP1: the proposed WEC and WTE are located adjacent to the west of the existing terminal building (in the west of the Airport); new stands and the taxiway are located across the north and west of KGV Dock; the ETE and Eastern Pier are located adjacent to the east of the existing terminal building; the EEC is located to the north of King George V House; the new forecourt area is located to the south of the ETE and KGV Dock; and areas of car parking, the taxi feeder zone and east car rental zone are located to the north of Hartmann Road.

1.5 Previous Reports

1.5.1 The information used and interpreted within this Contaminated Land Assessment and Outline Remediation Strategy includes that provided as part of a number of reports carried out for the wider Airport site, the CADP and also specifically for the WTE.

1.5.2 A chronological summary of these reports is provided in Table 1 below. Where relevant, reference is made to those exploratory holes located within CADP1 and those across the wider Airport site.

Table 1: Previous Reports

Prepared By	Report Title	Date of Report	Exploratory locations within CADP1 or the wider Airport
Soil Mechanics	London City Airport – Phase I Airside Improvement Programme: Factual Report on Ground Investigation (ref: 140013)	January 2001	None within CADP1. Across the wider Airport site: 74 trial pits and one cable percussion borehole.
Soil Mechanics	London City Airport – Phase 2 Airside Improvement Programme: Factual Report on Ground Investigation (ref: 141002)	October 2001	CADP1: One borehole in the area of the temporary coaching facility (BH104); one borehole in the area of the OBB (BH107); and two boreholes in the area of the ETE (BH108 and BH109). At the time of the investigation, these boreholes were located in KGV Dock. Across the wider Airport site: 12 cable percussion boreholes.
Fugro Engineering Services Limited	Contaminated Land Survey at London City Airport – Interpretive Report (ref: ENV063009)	May 2006	None within CADP1. Across the wider Airport site: Eight trial pits.
RPS	Phase 2 Environmental Site Investigation Report – London City Airport, Aircraft Stands and Car Park (ref: HLEC3237/004R)	May 2008	None within CADP1. Across the wider Airport site: Seven window sample boreholes, three cable percussion boreholes and seven trial pits.
Subadra	Environmental Investigation Report – BP Air Fuel Storage Area, London City Airport (ref: BPA08017 CL 002a)	January 2011	None within CADP1. Across the wider Airport site: Five geoprobe boreholes and two hand pits.
Subadra	Environmental Investigation Report – BP Airside Fuel (JetA1 and Diesel) Loading Area, London City Airport (ref: BPA08017 CL 003)	January 2011	None within CADP1. Across the wider Airport site: Three geoprobe boreholes.
Keltbray	London City Airport	June 2011	None within CADP1.

Prepared By	Report Title	Date of Report	Exploratory locations within CADP1 or the wider Airport
Environmental	Ledger Building Site Investigation Factual Report (report reference not provided)		Across the wider Airport site: Eight geoprobe boreholes.
Arcadis ES Harris	Environmental Site Assessment Report – BP Northair Fuel Storage and Distribution Areas (ref: 807880106_01)	February 2013	None within CADP1. Across the wider Airport site: Eight cable percussion boreholes.
Arcadis ES Harris	Detailed Quantitative Risk Assessment – BP Northair Fuel Storage and Distribution Areas (ref: 807880106_01)	March 2013	N/A
RPS	Phase 1: Preliminary Risk Assessment - City Airport Development Programme (ref: HLEI19695/001R)	May 2013	N/A
RPS	Phase 2: Environmental Site Investigation – London City Development Programme (ref: HLEI24974/001R Rev 2)	April 2013	CADP1: One window sample borehole (WS4) and one hand pit (HP2) in the area of the WTE. One window sample borehole (WS3) and one hand pit (HP1) in the area of the western service yard. Two window sample boreholes (WS7 and WS8) in the area of the ETE. One hand pit (HP6) in the area of the EEC. Three window sample boreholes (WS6, WS9 and WS10) and two hand pits (HP3 and HP5) in the area of the forecourt. Two window sample boreholes (WS12 and WS13) in the area of public passenger car park 1. Two window sample boreholes (WS14 and WS15) and one hand pit (HP7) in the area of public passenger car park 2. Two window sample boreholes (WS16 and WS17) in the area of public passenger car park 3. Two window sample boreholes (WS18 and WS19) and one hand pit (HP8) in the staff

Prepared By	Report Title	Date of Report	Exploratory locations within CADP1 or the wider Airport
			car park. Two sample boreholes (WS21 and WS22) and one hand pit (HP9) in the area of the taxi feeder zone. One window sample borehole (WS23) in the area of the east car rental zone. Across the wider Airport site: Three window sample boreholes.
RPS	Phase 2 Environmental and Geotechnical Site Investigation Report – London City Airport Western Terminal Extension (ref: HLEI32363/001R)	December 2014	CADP1: Two cable percussion boreholes (BH1 and BH2) in the area of the WEC and three cable percussion boreholes (BH3 to BH5) in the area of the WTE.
RPS	Updated Environmental Statement (UES) Chapter 16: Ground Conditions and Contamination for CADP	September 2015	N/A
Delta-Simons	Factual Ground Investigation Report: Evaluation of Ground Conditions – Airside City Airport Development Programme (ref: 16-0205.01v2)	July 2016	CADP1: 11 window sample boreholes (WS01, WS02, WS03, WS03A, WS03B, WS03C, WS06, WS201, WS202, WS203 and WS301) advanced across grassed area between taxiways Echo, Kilo, Lima and Mike, the runway turning circle and South Dock Road. A summary and interpretation of the findings of this report was provided within the 2016 Concept Geotechnical Interpretative Report.
Concept	Site Investigation Report, CADP Surveys Ground Investigation (Dock) – Phase 2 (ref: 16/2900 – FR 02)	April 2017	CADP1: Six boreholes (BH03 to BH07 and BH09) in the area of the ETE. 28 boreholes (BH10, BH10R, BH11 to BH21, BH21R, BH22 to BH25, BH25R, BH26 to BH34) in the area of the new aircraft stands, the parallel taxilane and the floating RVP pontoon. One trial pit (TP02) in the area of passenger car park 1.

Prepared By	Report Title	Date of Report	Exploratory locations within CADP1 or the wider Airport
			One trial pit (TP01) in the area of the staff car park. With the exception of BH06, TP01 and TP02, all of the exploratory holes were located in KGV Dock.
Concept	Geotechnical Interpretative Report, CADP Surveys Ground Investigation (Dock) – Phase 2 (ref: 16/2900 – IR 02)	July 2017	N/A

1.5.3 The known previous intrusive investigation locations carried out across CADP1 and the wider Airport site are indicated on Figures 1a and 1b.

1.5.4 RPS cannot vouch for the accuracy of the information provided within third party reports and legal reliance should be sought from the original authors of these reports where their content is considered material to the characterisation of the site.

1.6 Correspondence with Environment Agency

1.6.1 A meeting was held with the EA on 15th September 2016 to discuss the discharge of relevant conditions (including Condition 39) for the Interim Works. Given that previous site investigations had not found significant levels of contamination, the EA accepted that no further site investigation was necessary in order to meet the requirements of Condition 39.

1.6.2 A draft version of this document, only in relation to the area of the Interim Works, was submitted to the EA on 22nd December 2016 for their comment. In their response, dated 23rd February 2017 (ref: NE/2017/126435/01-L01), it was advised that they generally agreed with the site conceptualisation and the outline remediation strategy. In order to improve their understanding of the site, they requested further information and clarification on a number of points. A copy of the EA's letter of 23rd February 2017 is provided as Appendix B.

1.6.3 In addition, as agreed with Andy Goymer of the EA on 3rd March 2017, updated Piling Risk Assessments for the landside and dockside piling works associated with CADP1 were prepared by Atkins and TPS respectively. These reports are discussed in Section 9 and provided in full at Appendix G and F. The TPS report on piling in KGV Dock (Appendix F) further addresses the matters raised by Mr Goymer in his letter of 7th April (Appendix B).

2 HISTORICAL REVIEW

2.1 Review of Historical Maps

2.1.1 The following account of the site history is based upon past editions of Ordnance Survey (OS) maps dated 1869 to 2012. Relevant excerpts of historical maps are provided as Figure 2 to Figure 4.

2.2 On site

2.2.1 A review of the history for each part of CADP1 is provided in the following sections.

Western Energy Centre

2.2.2 The area of the WEC comprised marshland from at least 1869 until c.1938 when a road was indicated to run through the centre of this area. By c.1962, a railway line was indicated to be present to the north of the road. By c.1984, the railway line was no longer indicated to be present and by c.2006, the road was no longer indicated to be present. By c.2006, the area resembled a similar form/layout to the present day.

Western Terminal Extension

2.2.3 The area of the WTE comprised marshland from at least 1869 until c.1916, when a school encroached into the south of this area. The remainder of this area appeared to comprise undeveloped land, likely associated with the adjacent docks (to the north and east). By c.1938, a road was indicated to be present across the north of this area, running northwest/southeast (this is a continuation of the road which was present across the area of the WEC). By c.1962, a railway line was indicated to be present to the north of the road, but appears to have been removed by c.1984. By c.2006, the road and school were no longer indicated to be present, with the area resembling a similar form/layout to the present day.

Eastern Terminal Extension

2.2.4 The area of the ETE comprised marshland from at least 1869 until c.1896, when residential dwellings were indicated to be present in the southern part of this area. The majority of this area comprised part of the south of KGV Dock (started in 1912 and formally completed in 1921) and has remained as part of the dock until the present day. From c.1938 to c.1991, the far south of this area formed part of a wider area of warehouses associated with the Dock. From c.2006, the area resembled a similar form/layout to the present day.

Eastern Energy Centre

2.2.5 From c.1873, the area of the EEC was located within Woolwich Reach. By c.1896, Woolwich Reach was indicated to have been infilled and the area comprised vacant land. By c.1938, the area formed part of a wider area of warehouses associated with the Dock. By c.1981, the warehouse on site was no longer indicated to be present and the area comprised a works. By c.1986, the works was no longer indicated to be present and a small building of unspecified use was located in the east of the site. By c.1988, the area was indicated to comprise vacant land.

New Forecourt Area

2.2.6 From c.1873, the eastern part of this area was located within Woolwich Reach. By c.1896, Woolwich Reach was indicated to have been infilled and the area comprised residential dwellings and schools. By 1916, additional dwellings and two churches were present. By c.1938, two large warehouses with associated smaller buildings were present in this area. From c.1960, a works was indicated to be present in the southwest of the site. By 1990, the warehouses and works were no longer indicated to be present, however the smaller buildings of unspecified use were still shown. By c.2006, these buildings were no longer indicated to be present and the site resembled its current day layout.

Car Parking Areas, taxi feeder zone and east car rental zone

2.2.7 From c.1873, the far western part of this area was located within Woolwich Reach. By c.1896, Woolwich Reach was indicated to have been infilled. From at least 1869, the majority of the area comprised fields and vacant land. Several residential dwellings were present in the centre of the site. By c.1896, allotment gardens were present in the centre of this area and additional residential dwellings were present. By c.1916, the far west of this area comprised residential dwellings. From c.1938, five warehouses (associated with the Dock) were indicated to be present across the majority of this area. By c.1984, the warehouse in the west of the site was no longer indicated to be present. By c.1996, the remaining four warehouses were also not indicated to be present.

New stands, taxiway and floating RVP pontoon

2.2.8 The area of the new stands, taxiway and floating RVP pontoon comprised marshland from at least 1869. This area comprised part of the north of KGV Dock (started in 1912 and formally completed in 1921) and has remained as part of the dock until the present day.

2.3 Wider Airport Site and Surrounding Land Uses

2.3.1 The OS maps indicate that prior to 1869 the wider Airport site comprised predominantly of marshland. By c.1898, the Royal Albert Dock had been constructed to the north of the Airport site. A wharf with a number of warehouses had been constructed adjacent to the dock in the northern area of the Airport site and two associated dry docks had been constructed to the west. A 'composition works' was indicated to be present in the southwestern area of the wider Airport site and an engine works was located in the northwestern corner.

2.3.2 The construction of KGV Dock with associated warehouses started in 1912 and was formally completed in 1921. An associated dry dock was constructed to the west of KGV Dock. A wharf had been constructed to the south of KGV Dock and seven single storey transit sheds were constructed on the new wharf, with two associated railway lines.

2.3.3 By 1938, the engine works appeared to have been demolished. Additional warehouse buildings were shown in the northern area of the wider Airport site by c.1940. Works were indicated in the location of the former 'composition works' (labelled as a paint works in c.1959) and to the south of warehouses. By c.1984, a former office building in the northwestern corner of the wider Airport site was indicated to comprise a works and an additional works had replaced one of the warehouses adjacent to KGV Dock. This layout remained relatively unchanged until the Airport was constructed in c.1987.

2.3.4 Maps dating from 1991 indicated that the Airport occupied the majority of the current Airport site. The runway was located to the north of KGV Dock. Terminal buildings were present to the southwest of the runway and two of the former warehouses to the south of KGV Dock were no longer shown. The four remaining original warehouses were still indicated on OS mapping to be at the eastern extent of the dock. Aircraft stands were built upon a concrete apron piled into KGV Dock.

2.3.5 A number of railway lines and sidings have been historically present in the vicinity of the Airport.

2.3.6 Current proposed redevelopment plans indicate that an engineering facility is currently indicated to be present between the proposed public passenger car park 1 and car park 2. A fuelling facility is indicated to be between public passenger car park 2 and car park 3. It is understood that these facilities will remain as part of the proposed redevelopment.

2.3.7 Numerous former industrial land uses have been present approximately 100m to the south of the Airport site, between the railway line and the River Thames. A former gas works was located approximately 100m to the south of the Airport site from at least 1873, and to the east of this a sewage works and chemical factory were shown from 1896. By c.1920, the former sewage works was labelled as Cairn Oil Mills and the former chemical works was labelled as a wharf, with an electrical cable

works shown to the east. By c.1966 this area had been redeveloped and was indicated to comprise a number of works, industrial buildings and a factory. The gas works was no longer shown on the OS map at this time. By c.1974, the former gas works site was labelled as a sugar refinery and a number of tanks were indicated to be present. By c.1984 the area had been partially redeveloped again and the sugar refinery was no longer shown. The western section of the industrial area was labelled as Thameside Industrial Estate. By c.2006 further redevelopment had occurred to the east of Thameside Industrial Estate, and this area was labelled as Standard Industrial Estate.

2.3.8 Former industrial land uses, associated with Royal Victoria Dock (located to the west of the Airport site) and to the north of Royal Albert Dock (located to the north of the Airport site) included, at various times, a number of works of unspecified use, mills, depots, wharves and cranes.

3 ENVIRONMENTAL SETTING

3.1 Geology and Hydrogeology

3.1.1 The geological conditions beneath the wider Airport site are summarised within Chapter 16 of the UES (RPS, September 2015). The anticipated sequence of strata and aquifer classifications beneath the wider Airport site (based on British Geological Survey (BGS) mapping of the area (1:50,000-scale)), approximate thicknesses (based on the previous intrusive investigations), and the EA Groundwater Vulnerability mapping is presented in Table 2 below.

Table 2: Stratigraphic Sequence and Aquifer Classifications

Strata	Location across the wider Airport site	Description & approximate thickness	Aquifer Classification
Made Ground	Entire Airport site	Several metres	Not classified
Alluvium	Entire Airport site	Several metres	Secondary Undifferentiated Aquifer
River Terrace Deposits	Entire Airport site	Several metres	Secondary A Aquifer
Lambeth Group	Western area of the Airport site	Up to 30m, thinning towards the east	Secondary A Aquifer
Thanet Formation	Western and central areas of the Airport site	Up to 15m, thinning towards the east	Secondary A Aquifer
White Chalk Subgroup	Entire Airport site	In excess of 80m	Principal Aquifer

3.1.2 The site overlies a Secondary Undifferentiated Aquifer relating to the Alluvium. Secondary Undifferentiated Aquifers are formations which have varying characteristics in different locations. The River Terrace Deposits are classified as a Secondary A Aquifer. These formations are formed of permeable layers capable of supporting water supplies at a local scale and in some cases forming an important source of base flow to rivers. It is considered that shallow groundwater within this stratum may be in hydraulic continuity with the River Thames, located approximately 200m to the south of the site, at its closest point.

3.1.3 The Lambeth Group and the Thanet Formation are also classified as Secondary A Aquifers. The White Chalk Subgroup is classified as a Principal Aquifer; these formations provide a high level of water storage and may support water supply and / or river base flow on a strategic scale. It is considered that the overlying, variably permeable Alluvium will likely afford a degree of protection to these more sensitive groundwater bodies from contamination sourced within shallow soils and perched groundwater (if present).

3.1.4 According to EA data, CADP1 and the wider Airport site are not located within a groundwater Source Protection Zone (SPZ).

3.1.5 Under the Water Framework Directive, the EA's local River Basin Management Plan classifies groundwater chemical quality within the Lambeth Group, Thanet Formation and White Chalk Subgroup as poor.

3.1.6 There are no records of licensed groundwater abstractions within 1km of CADP1 and the wider Airport site.

3.2 CADP1 Area

Encountered Ground Conditions

3.2.1 A summary of the strata encountered during site investigations undertaken across the landside (including RPS, 2013; RPS, 2014 and Concept, 2016) and airside areas (including Delta-Simons, 2016) of CADP1 is provided in the table below:

Table 3: Description and Thickness of Strata beneath Landside Areas of CADP1

Strata	Location within CADP1	Description	Approximate Thicknesses (m)
Made Ground	Encountered in landside and airside exploratory holes	Comprised varying proportions of gravel, sand and clay	0.85 to 6.70
Alluvium	Encountered in each of the landside and airside exploratory holes (where holes were advanced to sufficient depth)	Comprised varying proportions of silt, clay, peat and sand	3.90 to 7.85
River Terrace Deposits	Encountered in each of the exploratory holes (where holes were advanced to sufficient depth)	Generally comprised sandy gravel and clayey sand	3.50 to 12.70
Lambeth Group	Not encountered during the site investigations	N/A	Absent
Thanet Formation	Encountered in each of the exploratory holes (where holes were advanced to sufficient depth)	Sand and slightly clayey sand. As part of the 2016 Concept investigation, a layer of flint gravel was observed at the base of the Thanet Formation within the borehole, this is known as the Bullhead Bed	11.8
White Chalk Subgroup	Encountered in each of the exploratory holes (where holes were advanced to sufficient depth)	Recovered as silty chalk gravel with bands of gravelly silt and occasional flint	>4.50 (full thickness not encountered)

3.2.2 A summary of the strata encountered during site investigations undertaken across KGV Dock areas of CADP1 (including Soil Mechanics, 2001 and Concept, 2016) is provided in the table below. The 2001 Soil Mechanics investigation encountered material described as Alluvium at the base of the Dock. In the 2016 Concept investigation, dock sediment was recorded. At the time of the investigations the depth of dock water ranged from approximately 9.20m and 14.00m.

Table 4: Description and Thickness of Strata beneath KGV Dock areas of CADP1

Strata	Location within CADP1	Description	Approximate Thicknesses (m)
Alluvium / Dock Sediment	Encountered in each of the exploratory holes, with one exception (BH14, Concept 2106)	Comprised varying proportions of silt, gravel, sand and clay	0.20 to 2.20 (where encountered)
River Terrace Deposits	Encountered in each of the exploratory holes, with one exception (BH12, Concept 2016)	Generally comprised sandy gravel, occasionally clayey and silty	0.20 to 7.50 (where encountered)
Lambeth Group	Not encountered during the site investigations	N/A	Absent
Thanet Formation	Encountered in each of the exploratory holes (where holes were advanced to sufficient depth) with the exception of boreholes BH28 and BH31 to BH34 (Concept, 2016)	Sand, slightly silty sand, slightly clayey sand and sandy clay. As part of the 2016 Concept investigation, a layer of flint gravel was observed at the base of the Thanet Formation within a number of boreholes, this is known as the Bullhead Bed.	0.10 to 17.40
White Chalk Subgroup	Encountered in each of the exploratory holes (where holes were advanced to sufficient depth)	Recovered as silty chalk gravel with bands of gravelly silt, silty gravel, occasional putty silt and flint	>27.00m (full thickness not encountered)

3.2.3 Exploratory hole logs for the boreholes and hand pits undertaken across CADP1 are provided as Appendix C.

3.2.4 Although BGS mapping indicates that the Lambeth Group is present across the west of CADP1, this stratum was not encountered during the site investigations.

Groundwater

3.2.5 A summary of the recorded groundwater levels across CADP1 is provided below. Ground elevation data was not collected as part of the 2013 and 2014 RPS investigations, so it has not been possible to determine groundwater elevations beneath the site, for these exploratory holes.

Made Ground

3.2.6 During the 2013 RPS investigation, groundwater was encountered within the Made Ground at depths ranging from 1.00m to 2.00m below ground level (bgl), during the drilling of boreholes WS14, WS15, WS17, WS18 and WS19.

3.2.7 During the 2016 Delta-Simons investigation, groundwater was encountered within the Made Ground at depths of 2.00m and 3.00m bgl, during the detailing of boreholes WS01 and WS06.

3.2.8 Groundwater monitoring wells were installed and screened across the Made Ground within ten of the boreholes (WS3, WS4, WS6, WS7, WS8, WS9, WS14, WS17, WS19 and WS22) advanced as part of the 2013 RPS investigation. During three subsequent monitoring rounds groundwater levels ranged from 0.80m to 4.22m bgl. Boreholes WS8 and WS9 were dry during the monitoring rounds.

3.2.9 Groundwater monitoring wells were installed within two boreholes (BH1(shallow) and BH4(shallow)) advanced as part of the 2014 RPS investigation. During three subsequent monitoring rounds groundwater was measured at the following levels:

- Borehole BH1 (shallow): 3.28m to 3.35m bgl; and
- Borehole BH4 (shallow): 3.03m to 3.05m bgl.

Alluvium

3.2.10 During the 2013 RPS investigation, groundwater was encountered towards the top of the Alluvium, at a depth of 4.80m bgl, during the drilling of borehole WS6.

3.2.11 During the RPS 2014 investigation groundwater was encountered towards the base of the Alluvium at a depth of 9.30m bgl during drilling in borehole BH3.

3.2.12 During the 2016 Delta-Simons investigation, groundwater was encountered towards the base of the Alluvium at a depth of 8.60m bgl during drilling in borehole WS02.

3.2.13 A groundwater monitoring well was installed and screened across the Alluvium within one borehole advanced as part of the 2013 RPS investigation (WS13). During three subsequent monitoring rounds, groundwater levels ranged from 2.82m to 2.86m bgl.

Two boreholes advanced as part of the 2014 RPS investigation were installed across the Alluvium. During subsequent monitoring rounds groundwater was measured at the following levels:

- Borehole BH2 (shallow): 3.27m to 3.57m bgl; and
- Borehole BH3 (shallow): 6.11m to 6.15m bgl.

River Terrace Deposits

3.2.14 During the 2013 RPS investigation, groundwater was encountered within the River Terrace Deposits at depths ranging from 3.50m to 4.50m bgl, during the drilling of boreholes WS9 and WS10.

3.2.15 During the RPS 2014 investigation groundwater was encountered at the top of the River Terrace Deposits at depths ranging from 8.90m to 9.60m bgl during drilling in boreholes BH1, BH2, BH4 and BH5.

3.2.16 Groundwater monitoring wells were installed and screened across the River Terrace Deposits within three boreholes advanced as part of the 2014 RPS investigation. During subsequent monitoring rounds groundwater was measured at the following levels:

- Borehole BH2 (deep): 5.34m to 5.41m bgl;
- Borehole BH3 (deep): 5.99m to 6.32m bgl; and
- Borehole BH4 (deep): 6.15m to 6.22m bgl.

Thanet Formation

3.2.17 During the 2016 Concept investigation, a groundwater seepage was encountered within the Thanet Formation at a depth of 19.50m bgl (-14.62m AOD) during the drilling of borehole BH13.

3.2.18 Groundwater monitoring wells were installed and screened across the Thanet Formation within two boreholes advanced as part of the 2014 RPS investigation. During subsequent monitoring rounds groundwater was measured at the following levels:

- Borehole BH1(deep): 3.99m to 5.57m bgl; and
- Borehole BH5: 6.06m to 6.08m bgl.

3.2.19 The groundwater levels measured within the Thanet Formation indicate that the groundwater body within this stratum is under artesian conditions.

White Chalk Subgroup

3.2.20 Groundwater monitoring wells have not been installed across the White Chalk Subgroup within any of the boreholes advanced across CADP1. However, it is considered likely that any groundwater within the White Chalk Subgroup is in continuity with that in the overlying Thanet Formation.

3.3 Hydrology

3.3.1 KGV Dock is situated to the east of the existing terminal building and the Royal Albert Dock is situated adjacent to the north of the runway. The Royal Victoria Dock is located approximately 70m to the western boundary of the Airport site. The River Thames is located approximately 200m to the south of CADP1, at its closest point.

3.3.2 KGV Dock is situated to the east of the existing terminal building and the Royal Albert Dock is situated adjacent to the north of the runway. The Royal Victoria Dock is located approximately 70m to the west of the Airport site. Information on the construction of KGV Dock (Binns, 1923) indicates that the sides of this dock are lined with concrete. From the information provided in the Binns document, it appears that the base of the dock is not lined, but instead comprises 'puddle clay'.

3.3.3 Information provided in the Heritage Scoping Study of the Royal Docks Masterplan Area (dated September 2010) states that the walls of the Royal Albert Dock are mostly of concrete, approximately 5.00m thick at the bottom, reducing to approximately 1.50m at the top. It has not been possible to obtain information regarding the construction of the base of the dock.

3.3.4 RoDMA (*pers. comm.)* has advised that between 2cm and 3cm of water is lost from the docks each day, for a range of reasons, such as leaks, evaporation and lock movements. They advised that the water level is not generally allowed to drop below 7.40m Chart Datum (CD) and is regularly brought back up to 7.65m CD by impound pumps. This can take up to four hours and is driven by the height and timing of the tides.

3.3.5 According to EA data, there is one watercourse within 1km of CADP1 which is classified within a River Basin Management Plan published by the EA under the European Water Framework Directive (2000). This is the River Thames, which is classified as having 'moderate' ecological quality and 'fail' for chemical quality.

3.3.6 There are records of two licenced surface water abstractions within 1km of the site. These both relate to abstractions from the River Thames by Tate and Lyle Sugars Ltd. The abstractions are recorded as being located approximately 375m and 480m to the south of the Airport.

4 PRELIMINARY CONCEPTUAL SITE MODEL

4.1 Background

4.1.1 A preliminary conceptual site model (CSM) consists of an appraisal of the *source-pathway-receptor* 'contaminant linkages' which is central to the approach used to determine the existence of 'contaminated land' according to the definition set out under Part 2A of the Environmental Protection Act 1990. For a risk to exist (under Part 2A), all three of the following components must be present to facilitate a potential 'pollutant linkage':

- **Source** referring to the source of contamination (Hazard).
- **Pathway** for the contaminant to move/migrate to receptor(s).
- **Receptor** (Target) that could be affected by the contaminant(s).

4.1.2 Receptors include human beings, other living organisms, crops, controlled waters and buildings / structures. The National Planning Policy Framework (NPPF) follows the same principles as those set out under Part 2A.

4.2 Potential Pollutant Linkages

4.2.1 Each stage of the potential pollutant linkages has been assessed individually on the basis of information provided in Sections 2 and 3 of this report and are discussed below.

Potential Contaminant Sources

On Site

4.2.2 From 1962 to c.1984 a railway line was indicated to be present across the area of the WTE and the WEC.

4.2.3 The far south of the ETE, the EEC, the new forecourt area, car parking areas, taxi feeder zone and east car rental zone have comprised warehouses, associated with KGV Dock, from c.1938 up until c.1981 to c.2006. A number of smaller buildings of likely associated use were also present in these areas.

4.2.4 From c.1960 until c.1990, a works was indicated to be present in the southwest of the new forecourt area.

4.2.5 The area of the EEC comprised a works from c.1981 to c.1986.

4.2.6 Made Ground has been encountered in exploratory holes advanced across CADP1. This could represent a potential source of contaminants of concern and ground gas.

Off-site

4.2.7 A number of former potentially contaminative land uses have been identified across the wider Airport site; these include wharves, warehouses, a composition works and an engine works. In addition, works, depots and mills were formerly located to the west of the Airport.

4.2.8 Current potentially contaminative land uses in the vicinity of CADP1 include the landside fuel storage area (located approximately 310m to the west), the airside fuelling station (located approximately 385m to the west), the engineering facility (located between the proposed public passenger car park 1 and car park 2) and the fuelling facility (located between the proposed public passenger car park 2 and car park 3).

Potential Pathways

4.2.9 The proposed surface cover across the majority of CADP1 will comprise building cover and hardstanding, together with a suspended concrete deck over KGV Dock. The risks to future on site human health receptors *via* the pathways of dermal contact and ingestion will therefore be mitigated in these areas.

4.2.10 It is understood that areas of soft landscaping are proposed to be included as part of the service yard associated with the WTE and the new forecourt area. In these areas, the pathways of dermal contact and ingestion could still be active. In addition, there is the potential for the airborne migration of soil/dust from these areas.

4.2.11 There is the potential for ground gas and volatile contaminants of concern in soil and/or groundwater beneath the site to impact future site users *via* the inhalation pathway in indoor areas.

4.2.12 Groundwater within the Made Ground, Alluvium and River Terrace Deposits may constitute a potential pathway for the on or off-site migration of contaminants of concern. These may impact neighbouring site users *via* the direct contact, ingestion and vapour inhalation pathways.

4.2.13 Potential contaminants of concern associated with historical land uses in the vicinity of the site also have the potential to migrate onto site *via* groundwater within the underlying permeable strata.

Potential Receptors

4.2.14 Potential human health receptors include Airport employees, passengers and visitors to the wider Airport site.

4.2.15 Provided construction workers adopt appropriate levels of hygiene and personal protective equipment, they are not considered to be at significant risk from potential contaminants of concern.

4.2.16 The site is situated on a Secondary Undifferentiated Aquifer relating to the Alluvium. The underlying River Terrace Deposits, Lambeth Group and Thanet Formation are classified as Secondary A Aquifers and the deep Chalk White Subgroup is classified as a Principal Aquifer.

4.2.17 KGV Dock is situated to the east of the existing terminal building and the Royal Albert Dock is situated adjacent to the north of the runway. The Royal Victoria Dock is located approximately 70m to the west of the Airport site.

4.3 Preliminary Conceptual Site Model

4.3.1 A preliminary CSM has been developed based on each of the stages discussed above. The CSM is used to identify potential sources, pathways and receptors (i.e. potential pollutant linkages) on site and is summarised in the table below:

Table 5: Preliminary Conceptual Site Model

Potential Source	Contaminants of Concern	*Via*	Potential Pathways	Linkage Potentially Active?	Receptors
On site – current: Made Ground **On site – historical:** Railway line, warehouses, works and buildings of unspecified use	Metals, hydrocarbons and asbestos	Soil	Dermal contact/ingestion	✓	Future site users
			Inhalation of volatiles	✓	
			Airborne migration of soil or dust	✓	Off-site users
			Leaching of mobile contaminants	✓ ✓ ✓	Alluvium Secondary Undifferentiated Aquifer River Terrace Deposits, Lambeth Group and Thanet Formation Secondary A Aquifers White Chalk Subgroup Principal Aquifer
		Groundwater	Dermal contact/ingestion	✓ ✓	Future site users Off-site users
			Inhalation of volatiles	✓ ✓	Future site users Off-site users

Potential Source	Contaminants of Concern	*Via*	Potential Pathways	Linkage Potentially Active?	Receptors
			Vertical and lateral migration in permeable strata	✓ ✓ ✓ ✓	Alluvium Secondary Undifferentiated Aquifer River Terrace Deposits, Lambeth Group and Thanet Formation Secondary A Aquifers White Chalk Subgroup Principal Aquifer KGV Dock, Royal Albert Dock and Royal Victoria Dock
Off site – historical: Wharves, warehouses, a composition works, an engine works, works, depots and mills **Off-site – current:** Landside fuel storage area, airside fuelling station, engineering facility and fuelling facility	Metals and hydrocarbons	Groundwater	Dermal contact/ingestion	✓	Future site users
			Inhalation of volatiles	✓	Future site users
On and off-site – Made Ground / natural strata or bio-degradation of contamination	Carbon dioxide and methane	Ground Gas	Inhalation of ground gas	✓ ✓	Future site users Off-site users
			Explosive risks	✓ ✓	Future site users Off-site users

5 CONTAMINATION ASSESSMENT

5.1 Introduction

5.1.1 As detailed within Table 1, a number of 'landside' site investigations have been undertaken across the wider Airport site. These investigations were not carried out to specifically inform the CADP, but are considered relevant in assessing general ground conditions and the potential for contamination across the wider Airport site. Summaries of these investigations are provided as Appendix D.

5.1.2 In summary, the landside site investigations carried out at the Airport over the past 12 years have only encountered localised areas of hydrocarbon and metal contamination within shallow soils. However, widespread contamination has not been detected and the investigations carried out to date have not revealed contamination that is considered likely to significantly impact the wider environment or CADP1.

5.1.3 A more detailed assessment of the results of contamination testing undertaken across the landside and airside areas of CADP1 is provided below. The results of the investigation across KGV Dock are discussed at the end of this chapter.

5.2 Landside Areas of CADP1

5.2.1 The following sections provide information on exploratory holes advanced across the CADP1 landside areas. A summary of the encountered contaminants of concern is provided below.

5.2.2 It should be noted that as part of the 2001 Soil Mechanics investigation (ref: 141002), no laboratory testing for potential contaminants of concern was undertaken on samples collected from the two boreholes advanced across CADP1.

Field Evidence of Contamination

5.2.3 Visual and/or olfactory evidence of contamination encountered within soils during the intrusive investigations undertaken across the landside areas of CADP1 is detailed below:

Table 6: Visual and/or Olfactory Evidence of Contamination

Date and Author of Investigation	Exploratory Hole ID	Depth (m bgl)	Strata	Observation
RPS, 2013	WS3	Ground level to 5.00m bgl	Made Ground	Ash fragments
		Ground level to 1.00m bgl	Made Ground	Clinker
		3.70 to 5.00	Made Ground	Ash fragments
	WS4	0.15 to 1.30	Made Ground	Ash fragments
		1.00	Made Ground	Slight hydrocarbon odour
		4.00 to 5.00	Made Ground (reworked Alluvium)	Ash fragments
	WS6	0.10 to 1.00	Made Ground	Ash fragments
		1.70 to 4.50	Made Ground (reworked Alluvium)	Ash fragments
	WS7	3.00 to 4.50	Made Ground	Ash fragments
	WS8	3.00 to 5.00	Made Ground	Ash fragments
	WS10	1.20 to 2.40	Made Ground	Ash fragments
		3.70 to 4.30	Made Ground	Ash fragments
	WS11	0.90 to 4.50	Made Ground	Ash fragments
	WS15	1.10 to 5.00	Made Ground	Ash and clinker fragments
	WS22	Ground level to 5.00	Made Ground	Ash fragments, becoming rare from 1.50m
	WS23	1.00 to 1.80	Made Ground	Ash fragments
RPS, 2014	BH2	0.50 to 1.80	Made Ground	Ash fragments
	BH3	0.70 to 0.90	Made Ground	Ash fragments
	BH4	0.85 to 2.00	Made Ground	Ash fragments
	BH5	4.00 to 4.80	Made Ground	Ash
Concept, 2016	BH06	6.10 to 6.50	Made Ground	Hydrocarbon odour
		6.50 to 6.70	Made Ground	Strong hydrocarbon odour
		7.10 to 9.20	Alluvium	Hydrocarbon odour

5.2.4 No visual or olfactory evidence of contamination was recorded within groundwater sampled from the monitoring wells installed across the landside areas of CADP1.

Soil Analysis

5.2.5 A total of 37 samples of Made Ground, six samples of Alluvium, two samples of River Terrace Deposits and one sample of Thanet Formation were submitted for chemical analysis as part of the RPS 2013 and 2014 site investigations and the Concept 2016 investigation from exploratory hole locations across landside areas of CADP1. Samples were analysed for a range of contaminants of concern including metals, speciated polycyclic aromatic hydrocarbons (PAH), speciated total petroleum hydrocarbons (TPH CWG) including benzene, toluene, ethylbenzene and xylene (BTEX) and methyl tert butyl ether (BTEX), monohydric phenol, volatile organic compounds (VOCs), semi-

volatile organic compounds (SVOCs) and asbestos. The laboratory certificates are provided as Appendix E.

5.2.6 Analytical results from the two RPS site investigations were compared to human health assessment criteria (AC) derived using CLEA v1.06 software for a commercial land use. Analytical results from the 2016 Concept investigation were compared to Suitable 4 Use Levels (S4UL) GAC published by Land Quality Management: Chartered Institute of Environmental Health (LQM:CIEH) in 2015. A notable exclusion from the S4ULs is lead. In the absence of a S4UL for lead, the Category 4 Screening Level (C4SL) was selected, published by DEFRA in 2014.

5.2.7 A summary of the relevant soil contamination encountered as part of the previous investigations carried out across the landside areas of CADP1 is detailed below.

Made Ground

5.2.8 None of the soil samples collected from borehole WS4 (advanced as part of the 2013 RPS investigation) recorded concentrations of contaminants of concern above relevant AC. However, elevated concentrations of TPH compounds in the C10 to C35 range (total 6,500mg/kg aliphatic and 2,900mg/kg aromatic compounds), were recorded within a soil sample collected at a depth of 0.80m bgl within borehole WS4. These concentrations coincided with a slight hydrocarbon odour that was recorded within the window sample borehole at this depth. TPH concentrations were below the limit of detection in a deeper sample taken at 2.00m bgl from the same borehole suggesting that this was an area of localised contamination in shallow Made Ground and that the contamination was not leaching to deeper soils.

5.2.9 Lead was recorded at a concentration in excess of the adopted AC (6,215mg/kg) within one sample of Made Ground collected from borehole BH5 at a depth of 4.10m bgl (25,000mg/kg). No other contaminants of concern were recorded within soil samples at concentrations in excess of relevant AC collected as part of the 2014 RPS investigation.

5.2.10 Chrysotile asbestos fibres were recorded within three samples collected from the Made Ground within borehole BH3 at a depth of 0.80m bgl and within borehole BH5 at depths of 0.60m and 4.10m bgl. Both boreholes were located within the footprint of the proposed WTE. Subsequent gravimetric asbestos quantification testing of these three samples did not detect the presence of asbestos at concentrations in excess of 0.001% w/w.

Alluvium

5.2.11 No concentrations of contaminants of concern analysed within the six samples of Alluvium (from boreholes WS6, WS9 and WS13 during the 2013 investigation and boreholes BH2 and BH4 in the 2014 investigation) collected from beneath landside areas of CADP1 exceeded the relevant AC.

River Terrace Deposits

5.2.12 No concentrations of contaminants of concern analysed within the samples of River Terrace Deposits (from borehole WS13 and BH1) collected from beneath CADP1 exceeded the relevant AC.

Thanet Formation

5.2.13 No concentrations of contaminants of concern analysed within the one sample of Thanet Formation (from borehole BH3) collected from beneath CADP1exceeded the relevant AC.

Groundwater Analysis

5.2.14 Groundwater samples were collected on one occasion as part of the 2013 and 2014 RPS investigations from eight monitoring wells screened across the Made Ground (WS3, WS4, WS6, WS7, WS17, WS19, WS22 and BH4 (shallow)); three monitoring wells screened across the Alluvium (WS13, BH2 (shallow) and BH3 (shallow)); three monitoring wells screened across the River Terrace Deposits (BH2 (deep), BH3 (deep) and BH4 (deep)); and two monitoring wells screened across the Thanet Formation (BH1 (deep) and BH5).

5.2.15 Groundwater samples were analysed for a range of contaminants of concern, similar to those for soils. The laboratory certificates are provided as Appendix E.

5.2.16 The results of chemical analysis of groundwater samples were compared to the Environmental Quality Standards (EQS) for freshwater. This was on the basis that the Alluvium, River Terrace Deposits and Thanet Formation aquifers were not used as potable water resources and the site was not located within a groundwater SPZ. Where EQS values were not available, the more sensitive UK Drinking Water Standards (DWS) were used as screening criteria.

Perched Groundwater

5.2.17 Arsenic was recorded at a concentration in excess of the EQS screening value of 50µg/l within the groundwater sample collected from monitoring well WS7, at a concentration of 1,300µg/l.

5.2.18 Copper was recorded at concentrations marginally in excess of the EQS screening value of 10µg/l within the groundwater samples collected from monitoring well WS3 (15µg/l), WS4 (35µg/l) and WS22 (16µg/l).

5.2.19 Selenium was recorded at a concentration marginally in excess of the UK DWS within a groundwater sample collected from monitoring well BH4 (shallow) (21µg/l), screened within the Made Ground. The UK DWS for selenium is 10µg/l.

Monitoring wells screened across the Alluvium

5.2.20 Aliphatic TPH compounds in the C16 to C35 range were recorded at concentrations in excess of the UK DWS (10µg/l) within a sample collected from monitoring well BH3 (shallow) (maximum of 54µg/l - aliphatic C21 to C35 range).

5.2.21 Aliphatic TPH compounds in the C16 to C21 range were recorded at concentrations in excess of the UK DWS (10µg/l) within a sample collected from monitoring well BH2 (shallow) (maximum of 12µg/l - aliphatic C16 to C21 range).

Monitoring wells screened across the River Terrace Deposits

5.2.22 Aliphatic TPH compounds in the C16 to C35 range were recorded at concentrations in excess of the UK DWS (10µg/l) within a sample collected from monitoring well BH2 (deep) (maximum of 110µg/l - aliphatic C21 to C35 range).

5.2.23 Aliphatic and aromatic TPH compounds in the C16 to C35 range were recorded at concentrations in excess of the UK DWS (10µg/l) within a sample collected from monitoring well BH3 (deep) (maximum of 640µg/l - aliphatic C21 to C35 range).

Monitoring wells screened across the Thanet Formation

5.2.24 Cyanide was recorded at a concentration in excess of the UK DWS within a groundwater sample collected from monitoring well BH1 (deep) (89µg/l). The UK DWS for cyanide is 50µg/l.

5.2.25 Phenanthrene (0.11µg/l), fluoranthene (0.11µg/l) and pyrene (0.15µg/l) were recorded at concentrations marginally in excess of the UK DWS for total PAH within a groundwater sample collected from monitoring well BH1 (deep). The UK DWS for total PAH is 0.10µg/l.

5.2.26 Aliphatic TPH compounds in the C16 to C35 range were recorded at concentrations in excess of the UK DWS (10µg/l) within a sample collected from monitoring well BH1 (deep) (maximum of 450µg/l - aliphatic C21 to C35 range).

Ground Gas Monitoring Results

5.2.27 As part of the 2013 RPS investigation, three rounds of ground gas monitoring were undertaken at monitoring wells WS3, WS4, WS6, WS7, WS8, WS14, WS17, WS19 and WS22, all screened across the Made Ground; monitoring well WS13, screened across the Alluvium; and monitoring well WS9, screened across the River Terrace Deposits. Monitoring was undertaken on 22nd January 2013, 27th January 2013 and 4th March 2013. Installations were monitored for concentrations of methane, carbon dioxide and oxygen. In addition, the flow rate and barometric pressure were recorded. Methane was not recorded at concentrations above the equipment limit of detection (<0.01% by volume (v/v)) during any of the monitoring rounds. Carbon dioxide was recorded at a maximum concentration of 8.3%v/v within monitoring well WS22, screened within the Made Ground on 22nd January 2013. Maximum ground gas flow rates of 0.1 litres/hour (l/hr) were recorded in monitoring wells WS3 and WS17, both screened across the Made Ground on 22nd January 2013. The lowest recorded oxygen concentration was 1.0%v/v, recorded within monitoring WS7, screened across the Made Ground on 27th January 2013. Atmospheric pressure ranged from 1013milibars (mb) to 1037mb during the monitoring period.

5.2.28 Ground gas monitoring was undertaken on three occasions, on 20th November, 1st and 5th December 2014 within monitoring wells BH1 (shallow and deep), BH2 (shallow and deep), BH3 (shallow and deep), BH4 (shallow and deep) and BH5 as part of the 2014 RPS investigation. Installations were monitored for concentrations of methane, carbon dioxide and oxygen. In addition, the flow rate and barometric pressure were recorded.

5.2.29 Methane was recorded at a maximum concentration of 7.4% v/v within monitoring well BH2 (deep), screened within the River Terrace Deposits on 21st November 2014. Carbon dioxide was recorded at a maximum concentration of 6.0% v/v within monitoring well BH1 (shallow) on 5th December 2014. The lowest recorded oxygen concentration was detected at 0.1% v/v within BH1 (deep), on 21st November 2014.

5.2.30 Ground gas flow rates of up to 40.0l/hr were recorded within monitoring well BH1 (deep), screened within the Thanet Formation. Atmospheric pressure ranged from 1025mb to 1016mb during the monitoring visits.

5.2.31 The CIRIA Report C665 ‘Assessing risks posed by hazardous ground gases to buildings’ outlines indicative guideline concentrations for carbon dioxide and methane in association with gas flow rates for which gas protection measures may be required in new residential or commercial developments. The methodology is based on the Modified Wilson and Card approach that characterises the gas

regime into a series of Characteristic Situations (1 to 5), with corresponding indicative gas protection measures. Using this methodology, the ground gas regime at this site corresponds to Characteristic Situation 3 (CS3).

5.2.32 However, taking into account ground gas concentrations within wells screened within the Made Ground and Alluvium only (and not including flooded response zones), the ground gas regime at this site corresponded to Characteristic Situation 2 (CS2), whereby basic gas protection measures would be required. This characterisation was deemed more appropriate, based on likely sources of ground gas associated with the site.

Waste Characterisation

5.2.33 As part of the 2013 RPS investigation, a waste characterisation exercise was carried out. Based on the information collected as part of the investigation, it was concluded that samples of Made Ground collected from boreholes WS3, WS16 and WS19 and a sample of Alluvium collected from borehole WS13 would be suitable for disposal as inert waste.

5.2.34 As part of the 2014 RPS investigation, a waste characterisation exercise was carried out. Based on the information collected as part of the investigation, the following waste classification/characterisation of soils beneath the WTE was made:

- The majority of Made Ground from the WTE site and underlying natural soils (Alluvium, River Terrace Deposits and the Thanet Formation) would likely be suitable for disposal as inert or non-hazardous waste;
- Made Ground from the vicinity of borehole BH5 (at approximately 4.10m bgl) would require disposal as stable non-reactive hazardous waste (SNRHW) due to elevated concentrations of copper, lead and zinc; and
- Made Ground from the vicinity of borehole BH4 (at approximately 0.45m bgl) would require disposal as hazardous waste due to a pH of 11.8. No further solid or Waste Acceptance Criteria (WAC) data was available to confirm the waste characterisation of this sample, however, the elevated pH concentration was considered attributable to concrete in this sample. Should the Made Ground from this area require disposal off-site, it was recommended that an acid-alkali reserve test be undertaken to assess the strength of the pH.

5.2.35 It was recommended that prior to disposal of any soil from the site that discussions are held with the landfill operator in advance.

5.2.36 As part of the 2016 Concept investigation, one sample of Made Ground (collected from BH06 at a depth of 2.50m bgl) was submitted for WAC analysis. This sample would be suitable for disposal as inert waste.

5.2.37 As part of CADP1, waste soils will be taken to a holding area within the site compound (east of the grey shed). Soils will be tested for a suite of potential contaminants of concern and dealt with by an approved licenced waste management company.

5.3 Airside Areas of CADP1

5.3.1 The following section provides information on exploratory holes advanced across the CADP1 airside areas. A summary of the encountered contaminants of concern is provided below.

Field Evidence of Contamination

5.3.2 Visual and/or olfactory evidence of contamination was not encountered within soils or groundwater during the 2016 Delta-Simons intrusive investigation, undertaken across the airside area of CADP1.

Soil Analysis

5.3.3 A total of seven samples of Made Ground were submitted for chemical analysis as part of the Delta-Simons 2016 investigation from exploratory hole locations across airside areas of CADP1. Samples were analysed for a range of contaminants of concern including metals, speciated PAH, TPH CWG including BTEX and BTEX and asbestos. The laboratory certificates are provided as Appendix E. The laboratory certificates refer to the two additional locations, labelled as E1 and E2, however no further information was provided regarding these locations.

Made Ground

5.3.4 Within the 2016 Concept report, reference was made to the 2016 Delta-Simons investigation. It was reported that a factual report was provided with no assessment of the soil analytical results. Concept therefore screened the results against S4UL and CS4L for a commercial use. No exceedances were reported.

5.3.5 Asbestos was identified in four samples of Made Ground. Chrysotile fibres/clumps were identified in a sample collected from borehole WS301, at a depth of 0.70m bgl; chrysotile lagging was identified in a sample collected from borehole WS06, at a depth of 1.10m bgl; and chrysotile cement was identified in sample E1 at a depth of 0.20m bgl. It appears that a duplicate sample for E1 (at 0.20m bgl) was analysed and chrysotile cement was also recorded in this sample. As discussed, above it has not been possible to determine what sample E1 relates to, as no further information was provided in the report. It is understood that quantification testing was not undertaken on any of the samples.

Groundwater Analysis

5.3.6 Laboratory results for three groundwater samples (WS01, WS02 and WS06) were provided as part of the 2016 Delta-Simons factual report. Given that the exploratory logs indicate that these boreholes were not installed with monitoring wells (and are backfilled), it is considered likely that these groundwater samples were collected during the drilling process.

5.3.7 The groundwater samples were analysed for a range of contaminants of concern, including metals and speciated PAH. The laboratory certificates are provided as Appendix E.

5.3.8 Within the 2016 Concept report, reference was made to the 2016 Delta-Simons investigation. It was reported that a factual report was provided with no assessment of the soil analytical results. Concept therefore screened the results and it was reported that marginally elevated concentrations of copper, lead and speciated PAHs were recorded and a significantly elevated concentration of zinc, when compared to EQS values.

Ground Gas Monitoring Results

5.3.9 It is understood that ground gas monitoring was not undertaken as part of the 2016 Delta-Simons investigation.

Waste Characterisation

5.3.10 It is understood that a waste characterisation exercise was not undertaken as part of the 2016 Delta-Simons investigation.

5.4 KGV Dock associated with CADP1

5.4.1 As discussed in Table 1, Concept undertook a site investigation in April 2017, across part of KGV Dock and an area to the south of the dock.

Field Evidence of Contamination

5.4.2 Visual and/or olfactory evidence of contamination encountered within soils during the intrusive investigation undertaken across KGV Dock is detailed below:

Table 7: Visual and/or Olfactory Evidence of Contamination

Date and Author of Investigation	Exploratory Hole ID	Depth (m bgl)	Strata	Observation
Concept, 2016	BH03	11.50 to 13.50	Dock Sediment	Strong hydrocarbon odour
	BH04	11.50 to 12.30	Dock sediment	Strong hydrocarbon odour
		12.30 to 13.50	River Terrace Deposits	
	BH05	12.55 to 14.00	River Terrace Deposits	Strong hydrocarbon odour
	BH07	11.80 to 12.80	Dock sediment	Strong hydrocarbon odour
		12.80 to 13.30	River Terrace Deposits	
		13.30 to 14.60	River Terrace Deposits	Hydrocarbon odour
	BH10	11.80 to 12.50	Dock sediment	Strong hydrocarbon odour
		12.50 to 13.25	River Terrace Deposits	
	BH10R	12.20 to 12.60	Dock sediment	Strong hydrocarbon odour
		12.60 to 12.70	River Terrace Deposits	
	BH11	13.50 to 13.80	Dock sediment	Strong hydrocarbon odour
		13.80 to 14.00	River Terrace Deposits	
	BH12	14.00 to 14.20	Dock sediment / River Terrace Deposits	Strong hydrocarbon odour
	BH14	12.50 to 13.50	Dock sediment / River Terrace Deposits	Strong hydrocarbon odour
	BH15	10.60 to 12.20	Dock sediment	Strong hydrocarbon odour
		12.20 to 12.75	Dock sediment / River Terrace Deposits	
		12.75 to 14.00	River Terrace Deposits	
		14.50 to 15.00	Thanet Formation	
	BH17	11.70 to 12.20	Dock sediment	Strong hydrocarbon odour
		12.20 to 14.50	River Terrace Deposits	
	BH18	11.50 to 12.50	Dock sediment	Strong hydrocarbon odour
	BH19	12.00 to 13.25	Dock sediment	Strong hydrocarbon odour
		12.25 to 15.25	River Terrace Deposits	
	BH21	11.80 to 13.10	Dock sediment	Strong hydrocarbon odour
		13.10 to 14.25	River Terrace Deposits	
	BH21R	13.40 to 1350	Dock sediment	Strong hydrocarbon odour
		13.50 to 16.00	River Terrace Deposits	
	BH22	12.70 to 13.50	Dock sediment	Strong hydrocarbon odour
		13.50 to 14.00	River Terrace Deposits	
	BH23	12.00 to 13.50	Dock sediment	Strong hydrocarbon odour
		13.50 to 14.10	River Terrace Deposits	
	BH24	11.50 to 12.80	Dock sediment	Strong hydrocarbon odour
		12.80 to 13.75	River Terrace Deposits	
	BH25	11.90 to 12.30	Dock sediment	Strong hydrocarbon odour and viscous texture
	BH25R	12.30 to 12.45	Dock sediment	Strong hydrocarbon odour
		12.45 to 13.50	River Terrace Deposits	
		24.95 to 25.10	White Chalk Subgroup	Purple staining
		25.90 to 6.00		
	BH26	12.00 to 12.50	Dock sediment	Strong hydrocarbon odour
		12.50 to 13.25	River Terrace Deposits	
	BH27	26.90	White Chalk Subgroup	Occasional purple staining
	BH28	12.00 to 13.10	Dock sediment	Strong hydrocarbon

Date and Author of Investigation	Exploratory Hole ID	Depth (m bgl)	Strata	Observation
		13.10 to 13.50	River Terrace Deposits	odour
	BH29	25.70	White Chalk Subgroup	Purple staining
		34.50 to 34.90		
	BH30	27.90	White Chalk Subgroup	Occasional purple staining
		29.00 to 29.20		
	BH31	12.00 to 12.50	Dock sediment	Strong hydrocarbon odour
		12.50 to 13.50	River Terrace Deposits	Hydrocarbon odour
	BH32	11.20 to 12.50	Dock sediment	Strong hydrocarbon odour
		12.50 to 13.00	River Terrace Deposits	
		13.00 to 13.70	River Terrace Deposits	Slight hydrocarbon odour
		21.80 to 22.10	White Chalk Subgroup	Purple staining
	BH33	12.20 to 13.50	Dock sediment	Strong hydrocarbon odour
		13.50 to 14.00	River Terrace Deposits	
		21.80	White Chalk Subgroup	Purple staining
	BH34	11.50 to 13.45	Dock sedimen	Strong hydrocarbon odour and viscous texture
		13.45 to 14.00	River Terrace Deposits	Strong hydrocarbon odour
		14.00 to 14.90		Slight hydrocarbon odour

Soil Analysis

5.4.3 Nine samples of dock sediment, 16 samples of River Terrace Deposits were submitted for chemical analysis as part of the 2016 Concept site investigation. Samples were analysed for a range of contaminants of concern including asbestos, metals, speciated PAH, TPH CWG including BTEX and BTEX, monohydric phenol, polychlorinated biphenyls (PCBs), VOCs and SVOCs. Analytical results from the 2016 Concept investigation were compared to S4UL GAC published by LQM:CIEH in 2015. A notable exclusion from the S4ULs is lead. In the absence of a S4UL for lead, the C4SL was selected, published by DEFRA in 2014.

5.4.4 A summary of the relevant soil contamination encountered as part of the previous investigation carried out across KGV Dock associated with CADP1 is detailed below.

Dock Sediment

5.4.5 Benzo(b)fluoranthene was recorded at a concentrations in excess of the adopted AC (44mg/kg) within one sample of dock sediment collected from borehole BH03 at a depth of 11.70m bgl (58.3mg/kg).

5.4.6 Benzo(a)pyrene was recorded at a concentrations in excess of the adopted AC (35mg/kg) within one sample of dock sediment collected from borehole BH03 at a depth of 11.70m bgl (91.8mg/kg).

5.4.7 Dibenzo(a,h)anthracene was recorded at a concentrations in excess of the adopted AC (3.5mg/kg) within one sample of dock sediment collected from borehole BH03 at a depth of 11.70m bgl (17.1mg/kg).

5.4.8 All of the above elevated PAH were recorded within a sample which had a strong hydrocarbon odour.

5.4.8 PCBs were recorded at a concentration in excess of the adopted AC (0.24mg/kg) within one sample of dock sediment collected from borehole BH31 at a depth of 12.00m bgl (0.28mg/kg). It should be noted that the AC for PCBs was based on the Soil Guideline Value (SGV) published in 2009.

River Terrace Deposits

5.4.9 No concentrations of contaminants of concern analysed within the 20 samples of River Terrace Deposits collected from beneath KGV Dock exceeded the relevant AC.

Leachate Analysis

5.4.10 Leachate testing was undertaken on one sample of dock sediment, four samples of River Terrace Deposits and one sample of Thanet Formation.

5.4.11 The results of chemical analysis of the leachate samples were compared to EQS and UK DWS.

5.4.12 An assessment of the leachate results indicated that elevated concentrations of hydrocarbons (including speciated PAH and TPH) and potentially phenols (when compared to UK DWS) were recorded. Localised exceedances of arsenic were also identified when compared to EQS values.

Groundwater / Ground Gas

5.4.13 Given that the majority of the boreholes were located within KGV Dock, no groundwater or ground gas monitoring was undertaken as part of the 2016 Concept site investigation.

Waste Characterisation

5.4.14 As part of the 2016 Concept investigation, two samples of dock sediment (collected from boreholes BH03 and BH34) were submitted for WAC analysis. Two samples of River Terrace Deposits (collected from boreholes BH03 and BH28) were also submitted for WAC analysis.

5.4.15 It was reported that the sample of dock sediment collected from borehole BH03 would require disposal as hazardous waste. The sample of dock sediment collected from borehole BH34 would require

disposal as non-hazardous waste. The two samples of River Terrace Deposits would require disposal as inert waste.

6 ENVIRONMENTAL RISK ASSESSMENT

6.1 Introduction

6.1.1 The UK approach to the management of land contamination through the development process is risk-based, as was formerly implemented by Planning Policy Statement Number 23 (PPS23). PPS23 was formally withdrawn on 27th March 2012 and replaced by the NPPF.

6.1.2 LBN is likely to have based its strategy for the implementation of the NPPF on the withdrawn PPS23. Therefore, this risk assessment will be based primarily on the withdrawn PPS23, with broad consideration for the contents of the NPPF.

6.1.3 The risk assessment methods adopted by PPS23 reflected those adopted by Part 2A of the Environmental Protection Act (1990). Part 2A identifies that harm to human health and the environment arises not solely from the presence of contaminating substances or 'sources', but from their migration along a 'pathway' to where they can impact a 'receptor'.

6.1.4 The potential pollutant linkages identified as part of the preliminary CSM have been assessed in light of the findings of the contamination assessment and are discussed below for each of the individual receptors identified.

6.2 Future Site Users

6.2.1 Future site users are considered to include Airport employees, passengers and other visitors to the Airport.

6.2.2 As part of the 2014 RPS site investigation, lead was recorded within a sample of Made Ground collected from beneath the site at a concentration in excess of its AC. Asbestos fibres were recorded within three samples of Made Ground collected from beneath the site. These locations are in areas of proposed building cover, which will break the pathways of dermal, ingestion and inhalation. No other contaminants of concern were recorded within soil samples collected from beneath the site at concentrations in excess of adopted AC.

6.2.3 As part of the 2016 Delta-Simons investigation, asbestos was identified in three samples of Made Ground collected from airside areas of CADP1. Within the 2016 Concept Geotechnical Interpretative Report it was considered that as these samples were collected from below concrete service roads and taxiways they were therefore currently not considered to pose a risk to site users.

6.2.4 It is understood that soft landscaping is proposed to be included as part of CADP1, within the service yard associated with the WTE and the new forecourt area. It is therefore recommended that, as a minimum, a 300mm validated clean topsoil cover layer should be installed in areas of soft landscaping.

6.2.5 Due to the depth to groundwater recorded beneath the site as (minimum of 0.80m bgl as part of the investigations carried out across landside areas of CADP1), it is not considered that future site users would come into contact with contaminants of concern within groundwater.

6.2.6 Volatile contaminants of concern were not recorded in soil samples collected from beneath the landside areas of CADP1 at concentrations exceeding their respective AC. None of the volatile compounds analysed from within groundwater were detected at concentrations considered to pose a potentially significant risk to future site users *via* the volatilisation pathway to indoor areas.

6.2.7 Overall, based on the available information, the potential risk to future site users from contaminants of concern originating landside areas of CADP1 is considered to be **LOW**.

6.2.8 Localised elevated concentrations of PAHs and a very marginally elevated concentration of PCBs were recorded within samples of dock sediment collected as part of the 2016 Concept site investigation. It was considered that the localised exceedances were not considered to represent a potential risk to human health receptors, given that the sediment was below approximately 11.50m of water and potential pathways would therefore not be active.

6.3 Off-Site Human Health Receptors

6.3.1 Off-site human health receptors are considered to include Airport employees, passengers and other visitors to other areas of the wider Airport site.

6.3.2 Lead and asbestos were recorded within Made Ground sampled from beneath landside areas of CADP1. However, following development, building cover, hardstanding and provision of clean topsoil cover in soft landscaped areas across the site will limit the potential for airborne migration of soil or dust to impact neighbouring receptors via the ingestion pathway.

6.3.3 Groundwater was encountered at a minimum depth of 0.80m bgl as part of the investigations undertaken across the landside areas of CADP1, meaning that the pathways of ingestion and direct contact are unlikely to be active for these receptors.

6.3.4 Furthermore, volatile contaminants of concern were not recorded in soil samples collected from beneath the site at concentrations exceeding their respective AC. None of the volatile compounds

analysed for within groundwater were detected at concentrations considered to pose a potentially significant risk to future site users *via* the volatilisation pathway to indoor areas. The vapour inhalation pathway is therefore not considered to represent a significant risk to off-site human health receptors.

6.3.5 Based on the available information, the potential risk to off-site human health receptors from potential contaminants of concern sourced from landside areas of CADP1 is considered to be **LOW**.

6.4 Ground workers

6.4.1 The derived AC cannot be used to assess the acute (short term exposure) risk that personnel in close contact with exposed soils may experience during demolition, redevelopment or site maintenance duties.

6.4.2 Asbestos was detected in three samples of Made Ground collected from two boreholes advanced across landside areas of CADP1 as part of the 2014 RPS site investigation. In addition, asbestos was identified in three samples of Made Ground collected as part of the 2016 Delta-Simons investigation, across airside areas of CADP1. It is therefore recommended that an asbestos management plan should be implemented. Should significant quantities of asbestos be detected in soils during site redevelopment, a specialist contractor will be approached to provide advice on removal and disposal.

6.4.3 Potential risks to construction workers involved in the excavation of soils can easily be controlled in most site areas by the use of appropriate personal protection equipment (disposable coveralls, gloves and particulate/vapour masks) and by adopting high levels of personal hygiene.

6.4.4 Depleted oxygen levels and elevated levels of methane and carbon dioxide may represent a risk to ground workers and appropriate precautions should be applied for personnel entering below ground confined spaces.

6.4.5 Providing contractors undertake and implement a site specific risk assessment (which should include details on the anticipated risks and necessary control measures) and appropriate mitigation measures are taken, based on the available information, the potential risk to ground workers is considered to be **LOW**.

6.5 Groundwater

6.5.1 An elevated concentration of arsenic was recorded within one of the boreholes. This appeared to be localised and significant concentrations of arsenic were not detected in down gradient boreholes. No significant soil source of arsenic was encountered during the investigation. Copper was detected locally at concentrations marginally in excess of the EQS within a number of groundwater samples

collected from beneath landside areas of CADP1. The measured concentrations within these monitoring wells are not considered to pose a significant risk to the wider groundwater environment.

6.5.2 Selenium, cyanide, TPH CWG and PAH were recorded at concentrations in excess of their relevant AC, within groundwater samples collected from beneath the landside areas of CADP1. All of these exceedances were in comparison to UK DWS screening criteria, which are considered overly conservative, given the limited resource potential of the Secondary and Principal Aquifers in the vicinity of the site.

6.5.3 The site is not located within a groundwater SPZ and there are no licensed groundwater abstractions within 1km of the site. Additionally, the chemical quality of groundwater beneath the site is classified as 'poor' under the EA River Basin Management Plan. Given that the only on site potential source of contaminants of concern is Made Ground, the concentrations encountered are considered to be representative of the wider area and not just attributable to CADP1 itself.

6.5.4 The potential for concentrations of contaminants of concern sourced from landside areas of CADP1 to pose a significant risk to groundwater receptors is therefore considered to be **LOW**.

6.5.5 As part of the 2016 Concept investigation, leachate testing was undertaken on one sample of dock sediment, four samples of River Terrace Deposits and one sample of Thanet Formation. Elevated concentrations of hydrocarbons (including speciated PAH and TPH) and potentially phenols (when compared to UK DWS) were recorded. Localised exceedances of arsenic were also identified when compared to EQS values. The risks to controlled waters from contamination identified on site were considered to be low. This was due to the site not being located within a groundwater SPZ, the dock being unlikely to be in hydraulic continuity with the underlying groundwater within the White Chalk Subgroup and the industrial past of the area which would have impacted upon the general groundwater quality in the area.

6.5.6 Within the 2016 Concept report, reference was made the 2016 Delta-Simons investigation, in which three groundwater samples were collected from boreholes advanced across airside areas of CADP1. Concept screened the results and it was reported that marginally elevated concentrations of copper, lead and speciated PAHs were recorded and a significantly elevated concentration of zinc, when compared to EQS values. It was considered that due to the site setting and general poor quality of groundwater (given the long history of industrial use), the area was considered to represent a low risk to controlled waters.

6.6 Surface Water

6.6.1 The groundwater level across the majority of the wider Airport site appears to be at significantly lower depth than the upper water level of the adjacent KGV Dock and is therefore not considered to be in hydraulic continuity with this receptor. Information on the construction of KGV Dock (Binns, 1923) indicates that the sides of this dock are lined with concrete. Information provided in the Heritage Scoping Study of the Royal Docks Masterplan Area (dated September 2010) states that the walls of the Royal Albert Dock are mostly of concrete, approximately 5.00m thick at the bottom, reducing to approximately 1.50m at the top.

6.6.2 The concrete serves as a barrier which would prevent the migration of any contaminated groundwater to these receptors. In addition, the docks leak and are regularly topped up by RoDMA (as discussed in section 3.3), further indicating that hydrostatic head pushes water out of the docks and that groundwater ingress is therefore unlikely.

6.6.3 Within the TPS Piling Risk Assessment Report (provided as Appendix F), it has been concluded that the preferred piling methods are likely to cause minimal disturbance to the dock bed silt due to the proposed instalment of the tubular pile casings by vibratory methods. Notwithstanding, the appointed contractor must as a minimum precautionary measure, carry out monitoring of the turbidity of the water at the surface and base of the Dock (at approximately 1m and 10m depth respectively) throughout the duration of the piling works. If the piling is found to be generating a notable increase the quantities of suspended silts in the water column, contractors will be required to adopt further preventative measures. Such measures must include 'silt curtains' or equivalent containment measures or working methods on the dock bed to prevent dispersal of dock bed silt and thereby contain any potential contamination – either in free phase or bound with the silt particles. The appointed contractor will be required to set out such preventative/ contingency measures within their method statement and to agree these with LCA and RoDMA prior to piling works commencing.

6.6.4 Coupled with the above, a formal water quality monitoring programme shall be developed in consultation with the EA and RoDMA. A three phase water quality-monitoring programme shall be carried out throughout the piling works, which will comprise: daily monitoring for pH, turbidity and dissolved oxygen; fortnightly monitoring of Total Petroleum Hydrocarbon (TPH), Polyaromatic Hydrocarbon (PAH), organotins and PCBs; and, monthly monitoring of arsenic, cadmium, lead, mercury, chromium, copper, nickel and zinc. Should elevated concentrations of these contaminants be identified in water samples then an appropriate plan for dealing with the contamination will be put in place. The nature and extent of the contamination shall be fully investigated, a risk assessment carried out to identify any potential ongoing risks to sensitive receptors and, if necessary, these risks will be mitigated to the satisfaction of LBN and the EA. Monitoring of these contaminants will also be undertaken once prior to the piling works commencing (to establish the baseline water quality

conditions) and on 3 separate occasions in the 6 months period after cessation of the piling works in order to demonstrate no permanent changes to water quality caused by the activity.

6.6.5 The potential for concentrations of contaminants of concern sourced from CADP1 to pose a significant risk to surface water receptors is therefore considered to be **LOW**.

6.7 Structures and Infrastructure

Buildings

6.7.1 Ground gas monitoring undertaken on site as part of the RPS 2014 investigation indicated that CIRIA Characteristic Situation 3 (CS3) was applicable. However, taking into account ground gas concentrations within wells screened within the Made Ground and Alluvium only (and not including flooded response zones) the ground gas regime at this site corresponded to Characteristic Situation 2 (CS2), whereby basic ground gas protection measures would be required.

6.7.2 Assuming the recommended mitigation measures are adopted, the risk posed by ground gas to on site human health receptors and infrastructure is considered to be **LOW**.

6.7.3 Ground gas protection measures should be designed in accordance with BS8485:2015 'Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings'. In addition, the installation of the gas protection measures should be verified by an independent qualified party (as recommended with CIRIA guidance document C735) and approved by Building Control.

6.7.4 It should be noted that risks of ground gas ingress or permeation of hydrocarbons into underground services in the CADP apron deck would not exist where construction is above the existing dock, due to the absence of underlying soils.

Polymeric Utility Pipes

6.7.5 Elevated concentrations of hydrocarbon contaminants were recorded within samples collected from beneath landside areas of CADP1. As outlined within Chapter 16 of the UES, barriers may be required for new underground utilities, or service pipes laid in dedicated trenches and backfilled with clean, inert material. Requirements for buried utility pipes will be discussed with service providers before the development stage.

6.7.6 Assuming appropriate mitigation measures are adopted, the risk posed to buried services is considered to be **LOW**.

6.8 Revised Conceptual Model

6.8.1 The potential source-pathway-receptor linkages and associated risks upon completion of the proposed development of CADP1, as identified following completion of the assessment, are summarised in the revised CSM below.

Table 8: Revised Conceptual Site Model

Potential Source	Contaminants of Concern	*Via*	Potential Pathways	Linkage Potentially Active?	Receptors
On site – current: Made Ground **On site – historical:** Railway line, warehouses, works and buildings of unspecified use	Metals, hydrocarbons and asbestos	Soil	Dermal contact/ingestion	✖	Future site users
			Inhalation of volatiles	✖	
			Airborne migration of soil or dust	✖	Off-site users
			Leaching of mobile contaminants	✖ ✖ ✖	Alluvium Secondary Undifferentiated Aquifer River Terrace Deposits, Lambeth Group and Thanet Formation Secondary A Aquifers White Chalk Subgroup Principal Aquifer
		Groundwater	Dermal contact/ingestion	✖ ✖	Future site users Off-site users
			Inhalation of volatiles	✖ ✖	Future site users Off-site users
			Vertical and lateral migration in permeable strata	✖ ✖ ✖ ✖	Alluvium Secondary Undifferentiated Aquifer River Terrace Deposits, Lambeth Group and Thanet Formation Secondary A Aquifers White Chalk Subgroup Principal Aquifer KGV Dock, Royal Albert Dock and Royal Victoria Dock
Off site – historical: Wharves, warehouses, a composition works, an engine works, works, depots and mills **Off-site – current:** Landside fuel storage area, airside fuelling station, engineering facility and fuelling facility	Metals and hydrocarbons	Groundwater	Dermal contact/ingestion	✖	Future site users
			Inhalation of volatiles	✖	Future site users
On and off-site – Made Ground / natural strata or	Carbon dioxide and methane	Ground Gas	Inhalation of ground gas	✖ ✖	Future site users Off-site users

Potential Source	Contaminants of Concern	*Via*	Potential Pathways	Linkage Potentially Active?	Receptors
bio-degradation of contamination			Explosive risks	✖ ✖	Future site users Off-site users

7 CONCLUSIONS / RECOMMENDATIONS

7.1.1 Lead and asbestos were recorded within Made Ground sampled from beneath landside areas of the site. However, following development, this area will comprise building cover and therefore the pathways of dermal contact or ingestion to future site users will not be active. The potential for airborne migration of soil or dust to impact neighbouring receptors will also be negligible. It is understood that soft landscaping is proposed to be included as part of CADP1, within the service yard associated with the WTE and the new forecourt area. It is therefore recommended that, as a minimum, a 300mm validated clean topsoil cover layer should be installed in areas of soft landscaping. Volatile contaminants were not detected at significant concentrations within soils or groundwater sampled from beneath landside areas. The vapour inhalation pathway is therefore not considered to represent a significant risk to on or off-site human health receptors. Localised elevated concentrations of PAHs and a very marginally elevated concentration of PCBs were recorded within samples of dock sediment collected as part of the 2016 Concept site investigation. It was considered that the localised exceedances were not considered to represent a potential risk to human health receptors, given that the sediment was below approximately 11.50m of water and potential pathways would therefore not be active. Based on the available information, the potential risk to human health receptors from potential contaminants of concern sourced from the site is considered to be **LOW**.

7.1.2 Arsenic, copper, selenium, cyanide, TPH CWG and PAH were recorded at concentrations generally only marginally in excess of available AC, within groundwater samples collected from beneath the landside area of the site. All of these exceedances were related to UK DWS screening criteria, which are considered overly conservative, given the limited resource potential of the Secondary and Principal Aquifers in the vicinity of the site. As part of the 2016 Concept investigation, elevated concentrations of hydrocarbons (including speciated PAH and TPH) and potentially phenols (when compared to UK DWS) were recorded within leachate samples collected from beneath KGV Dock. Localised exceedances of arsenic were also identified when compared to EQS values. The risks to controlled waters from contamination identified on site were considered to be low. Within the 2016 Concept report, reference was made to the 2016 Delta-Simons investigation, undertaken across airside areas of CADP1. It was reported that a factual report was provided with no assessment of the soil analytical results. Concept therefore screened the results and it was reported that marginally elevated concentrations of copper, lead and speciated PAHs were recorded and a significantly elevated concentration of zinc, when compared to EQS values. The risks to controlled waters from contamination identified across the area were considered to be low. This was due to the site not being located within a groundwater SPZ, the dock being unlikely to be in hydraulic continuity with the underlying groundwater within the White Chalk Subgroup and the industrial past of the area which would have impacted upon the general groundwater quality in the area.

7.1.3 The nearest surface water receptors to the site are the KGV and Royal Albert Docks. These feed into the River Thames, which, due to its large dilution potential, is not considered to be at significant risk from the relatively minor concentrations of contaminants of concern within groundwater samples collected from beneath the site. On the basis of the above, the potential for concentrations of contaminants of concern sourced from the site to pose a potentially significant risk to groundwater receptors is considered to be **LOW**.

8 OUTLINE REMEDIATION STRATEGY

8.1 Introduction

8.1.1 Part b) of Condition 39 states that an Outline Remediation Strategy for the site is required. This has been prepared on the basis of the findings of the previous intrusive investigations undertaken across CADP1 and the findings of the environmental risk assessment as presented in Section 6 of this document. The proposed remedial measures are to be undertaken to satisfy Part c) of Condition 39 and are outlined in the sections below.

8.2 Handling and Disposal of Materials

8.2.1 Should any soils require off-site disposal as part of the redevelopment, all surplus materials will be transferred to appropriately licensed waste management facilities by registered waste carriers under the relevant Duty of Care. It will be ensured that waste is stored and transported appropriately and securely; that waste is only transported and handled by those that are authorised to do so; and that all relevant documentation is completed, including waste transfer notes.

8.2.2 It is understood that soil arisings will be generated from piling through the dock sediments (in order to construct the new stands and taxiway). Samples from across this area were collected and analysed for a range of contaminants of concern as part of the 2016 Concept site investigation. As discussed in the sections above, the sediment at the base of the dock contained localised elevated concentrations of PAHs and a very marginally elevated concentration of PCBs. An assessment of the leachate results indicated that elevated concentrations of hydrocarbons (PAH and TPH) and potentially phenols were identified when compared to UK DWS. Localised exceedances of arsenic were identified when compared to EQS values. The TPS Piling Risk Assessment (as discussed in the section below) provides information regarding the steps that will be taken to ensure the safe removal and disposal of dock bed silts brought to the surface during the works. It is understood that the precise methodology for this will be confirmed upon appointment of the Piling and Deck Contractor.

8.2.3 Further information on the dock pile arisings is provided as part of Condition 70: Waste Management Strategy for CADP1 (dated March 2017). The management of waste arising from the sediments removed from the base of KGV Dock during piling will need careful attention and specialist equipment because this will take place in a marine environment. A proposed methodology to ensure the safe removal and disposal of this material has been provided as part of the Waste Management Strategy.

8.2.4 Should any obstructions be encountered at the base of the dock that would inhibit piling operations, such as demolition rubble, the material may have to be removed to allow piling work to continue. Should that material contain commination not previously identified by the previous onsite assessments

or if it requires disposal techniques not considered as part of this remediation strategy or the details approved under Condition 70, a bespoke method statement would be shared with LBN and the EA prior to removal of that material.

8.3 Mitigation Measures for Human Health Receptors

Importation of Clean Cover

8.3.1 It is understood that areas of soft landscaping are proposed to be included as part of the service yard associated with the WTE and the new forecourt area. A validated clean topsoil cover layer of at least 300mm will be installed in these areas.

8.3.2 In-situ sampling of imported material at a rate of one every 50m^3 or one per landscaped area, whichever is the smallest, will be carried out on any cover system. Sampling will be undertaken from hand pits completed within the imported material with scaled photographs taken to confirm that the required depth of cover layer has been installed and that the imported material is homogenous. Samples will be screened on site using a portable Photo-Ionisation Detector (PID).

8.3.3 Soil samples will subsequently be submitted to a UKAS/MCERTS accredited laboratory for chemical analysis for appropriate contaminants of concern. The results of the analysis will be compared to appropriate AC to ensure suitability for use.

Installation and Verification of Ground Gas Membrane

8.3.4 It was recommended that ground gas protection measures commensurate with CS2, should be installed within buildings constructed as part of the landside areas of CADP1. These measures may comprise a well-constructed floor slab with minimal service penetrations together within either a gas proof membrane or passive underfloor venting. All joints and penetrations will need to be sealed and lapped.

8.3.5 Ground gas protection measures should be designed in accordance with BS8485:2015 'Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings'. In addition, the installation of the gas protection measures should be verified by an independent qualified party (as recommended with CIRIA guidance document C735) and approved by Building Control.

8.3.6 This will ensure that sufficient evidence is collected to show that the membrane (if used as part of the ground gas protection measures) has been installed in-line with best practice and / or the

manufacturer's guidelines. To support this evidence, a photographic log must be kept showing lapping, seals, joints and service penetrations.

8.3.7 It should be noted that risks of ground gas ingress or permeation of hydrocarbons into underground services in the CADP apron deck would not exist where construction is above the existing dock, due to the absence of underlying soils.

Upgraded Services

8.3.8 Elevated concentrations of hydrocarbon compounds were recorded within samples collected from shallow soils on site. Requirements for buried utilities will be discussed with service providers before the development stage. Barrier pipe (a reinforced pipe used to protect water supplies against certain types of contaminants of concern) may be required for new underground utilities, or service pipes laid in dedicated trenches and backfilled with clean, inert material.

Construction Workers

8.3.9 Construction workers may be exposed to contaminated soils and groundwater during ground works. Suitable measures to protect construction workers are envisaged to include clean/dirty working practices, provision of appropriate personal protection equipment (PPE) including gloves, provision of adequate welfare/hygiene facilities as well as explanations of the potential risks. Operatives should be prohibited from eating, drinking or smoking within contaminated areas.

8.3.10 Asbestos has been recorded within three samples of Made Ground collected as part of the 2014 RPS site investigation. In addition, as part of the 2016 Delta-Simons investigation, asbestos was identified in three samples of Made Ground collected from boreholes advanced across airside areas of CADP1. A formal Asbestos Management Plan should be implemented prior to work commencing on site. Should significant quantities of asbestos be detected in soils during any site redevelopment, a specialist contractor will be approached to advise on removal and disposal.

8.3.11 Depleted oxygen and elevated carbon dioxide levels may represent a risk to ground workers and appropriate precautions will be applied for personnel entering below ground confined spaces.

8.4 Discovery Strategy/Watching Brief

8.4.1 A watching brief will be carried out during construction for previously unidentified landside contamination In accordance with Part d) of Condition 39. The process that will be utilised during the watching brief will comprise identification of contamination, assessment, isolation, remediation and re-use/disposal options. Further information on this is provided below as part of the discovery strategy.

8.4.2 A discovery strategy for any previously un-encountered landside contamination shall be implemented as part of the redevelopment. RPS or another suitably qualified environmental consultant will be contacted, where any significant visual or olfactory evidence of contamination, not previously encountered, is identified by construction workers during the development works. Any construction activities in the area of this material shall cease until an appropriate plan for dealing with the contamination has been put in place, in accordance with Part e) of Condition 39. The nature and extent of the contamination shall be fully investigated, a risk assessment carried out to identify any potential risks to sensitive receptors during and following construction and, if necessary, these risks will be mitigated to the satisfaction of LBN and the EA.

8.5 Validation Report

8.5.1 A Validation Report will be issued upon completion of CADP1 to confirm completion of the above measures. The reports will be submitted to LBN for review and approval, to support the discharge of Part f) of Condition 39 of the planning permission. Where relevant, the reports will include the following information:

- Scaled photographs to confirm the depth of the cover layer installed in areas of soft landscaping across the site, where required;
- Logs of hand pits completed including PID results;
- Results of chemical analysis for soil samples taken from imported topsoil;
- Comparison of the chemical results of topsoil to appropriate assessment criteria;
- Details of any additional remediation measures implemented upon receipt of these results or upon encountering any previously un-encountered contamination;
- Verification of the installation of gas protection measures; and
- Duty of Care documentation, including waste transfer notes.

8.5.2 The final Validation Report will be produced in-line with current best practice and include a photographic record of all works undertaken.

8.5.3 Any requirement for longer term monitoring of pollutant linkages and maintenance post redevelopment will be determined upon completion of the works.

9 PILING RISK ASSESSMENTS

9.1 Piling within KGV Dock

9.1.1 A Piling Risk Assessment Report relating to piling in KGV Dock was undertaken by TPS in January 2018. A copy of this report is provided as Appendix F. The TPS Piling Risk Assessment Report sets out the proposed method of piling as a bored pile with a permanent steel casing ('Vibrodriver Casing and Rotary Bore'). It was stated that alternatively, driven hollow steel piles could be used. However, as rotary bored piles in permanent steel casing had been carried out successfully at the airport during previous developments, these were assessed to be the most practicable piling method. It was concluded that both proposed methods provide a permanent steel casing which will protect the underlying aquifers by preventing pollutants from the dock silt and/or dock water entering the natural ground or underlying aquifers. Overall, with the proposed methods of piling and the implementation of recommended mitigation measures, the risk to controlled waters and other vulnerable receptors from the contamination identified in the dock sediment was considered to be low and no further remedial measures were considered necessary.

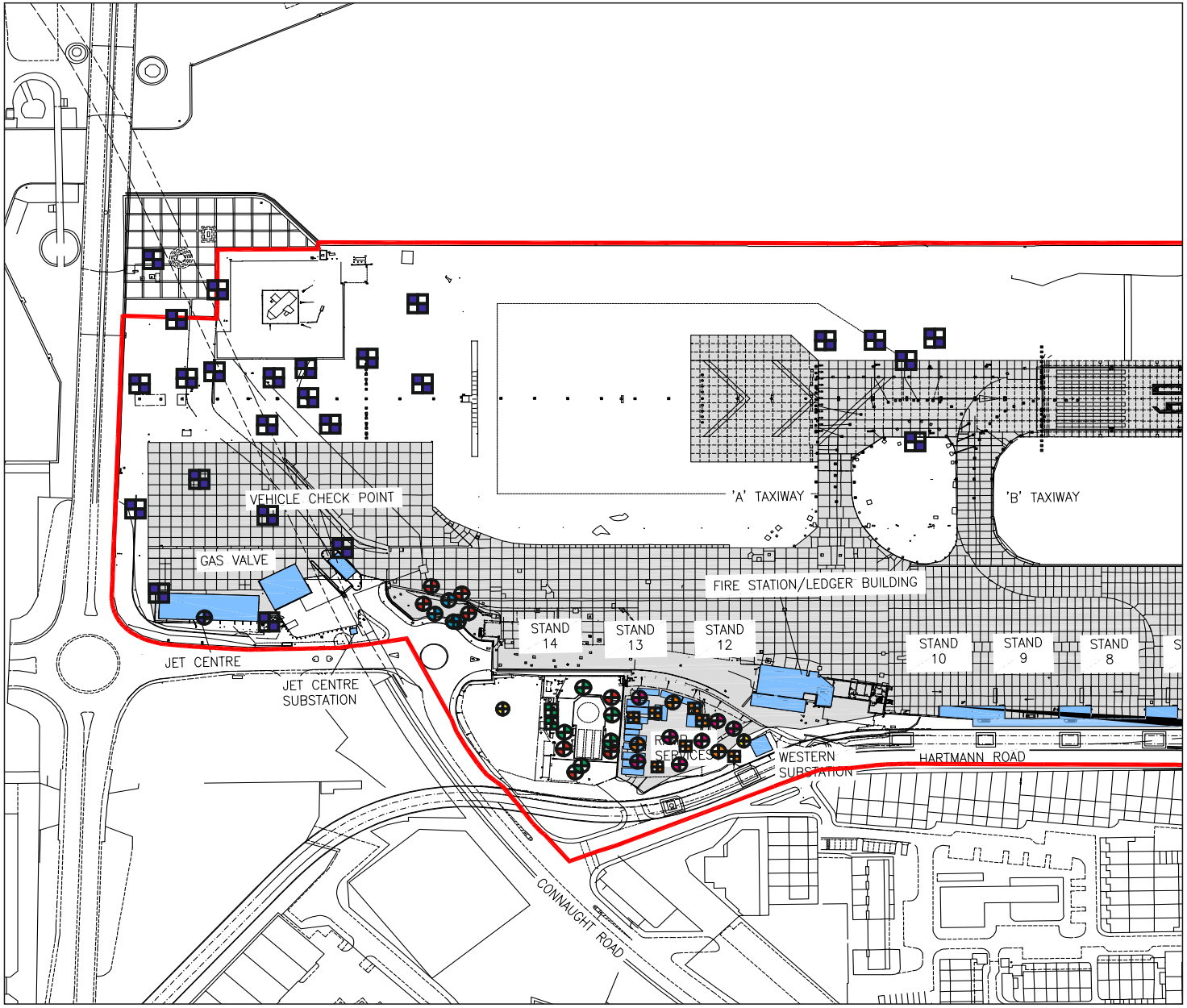
9.2 Piling on Landside Areas

9.2.1 A Piling Risk Assessment for the Western Energy Centre and Western Terminal Extension was undertaken by Atkins in March 2017. A Piling Risk Assessment for the Eastern Energy Centre and Multi Storey Car Park was also undertaken by Atkins in December 2017. Copies of these reports are provided as Appendix G.

9.2.2 Based on the available ground investigation data and the proposed piling methodology (CFA or rotary bored with temporary casing), the assessments have shown that there is a low risk to controlled waters receptors. Therefore no additional environmental monitoring is considered to be required.

9.2.3 Within the March 2017 report, relating to the Western Energy Centre and Western Terminal Extension, it was recommended that all Made Ground pile arisings should be assessed during the works to ensure that waste classification and subsequent disposal is appropriate. All pile arisings going off-site would need to be classified / assessed in accordance with appropriate Waste Management Legislation and guidance and materials managed under Duty of Care. A safe method of work would need to be adopted for workers exposed to potentially contaminated pile arisings, specifically to limit dermal contact and ingestion pathways.

FIGURES



Key:

- Window Sample Location - RPS, April 2013
- Borehole Location - Arcadis, February 2013
- Borehole Location - Subadra, January 2011
- Borehole Location - Subadra, January 2011
- Hand Pit Location - Subadra, January 2011
- Borehole Location - RPS, May 2008
- Window Sample Location - RPS, May 2008
- Trial Pit Location - RPS, May 2008
- Trial Pit Location - Soil Mechanics, January 2001
- Borehole Location - Soil Mechanics, January 2001

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Client: London City Airport

Project: CADP 1

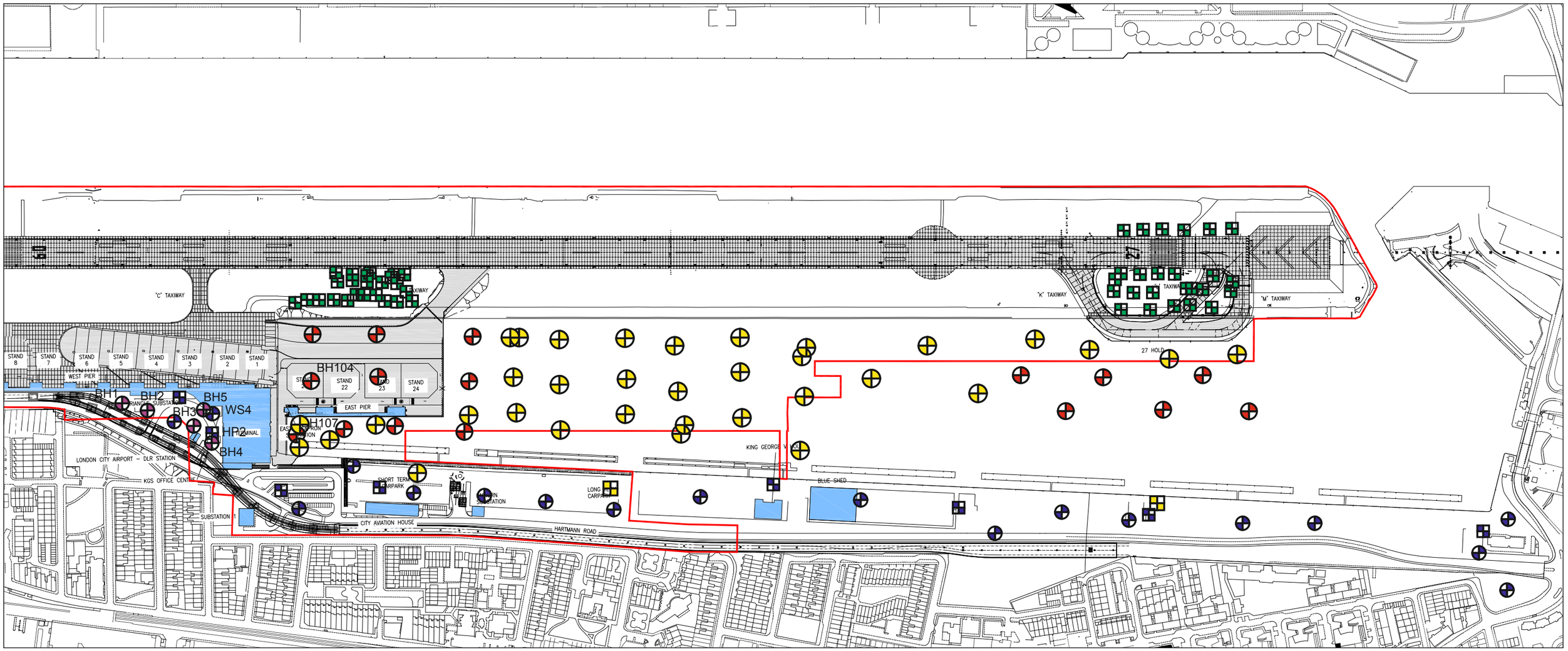
Title: Composite plan showing previous site investigation locations

Date: Oct 2017

Figure: 1A

Scale: NTS

Rev: 00



Key:

- Borehole Location - Soil Mechanics, October 2001
- Trial Pit Location - Soil Mechanics, January 2001
- Window Sample Location - RPS, April 2013
- Hand Pit Location - RPS, April 2013
- Borehole Location - RPS, December 2014
- Borehole Location - Concept, April 2017
- Trial Pit Location - Concept, April 2017

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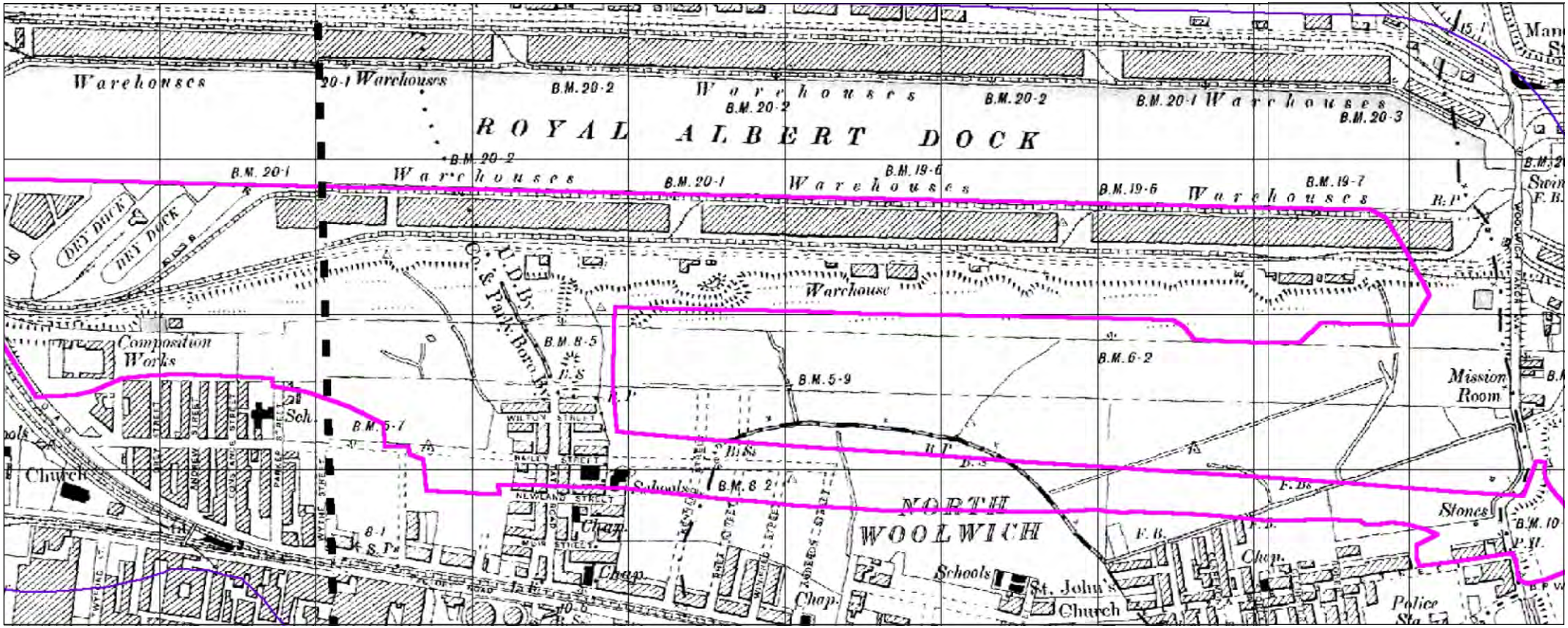
Date: Oct 2017

Figure: 1B

Scale: NTS

Rev: 00



Key:

Airport Site

RPS

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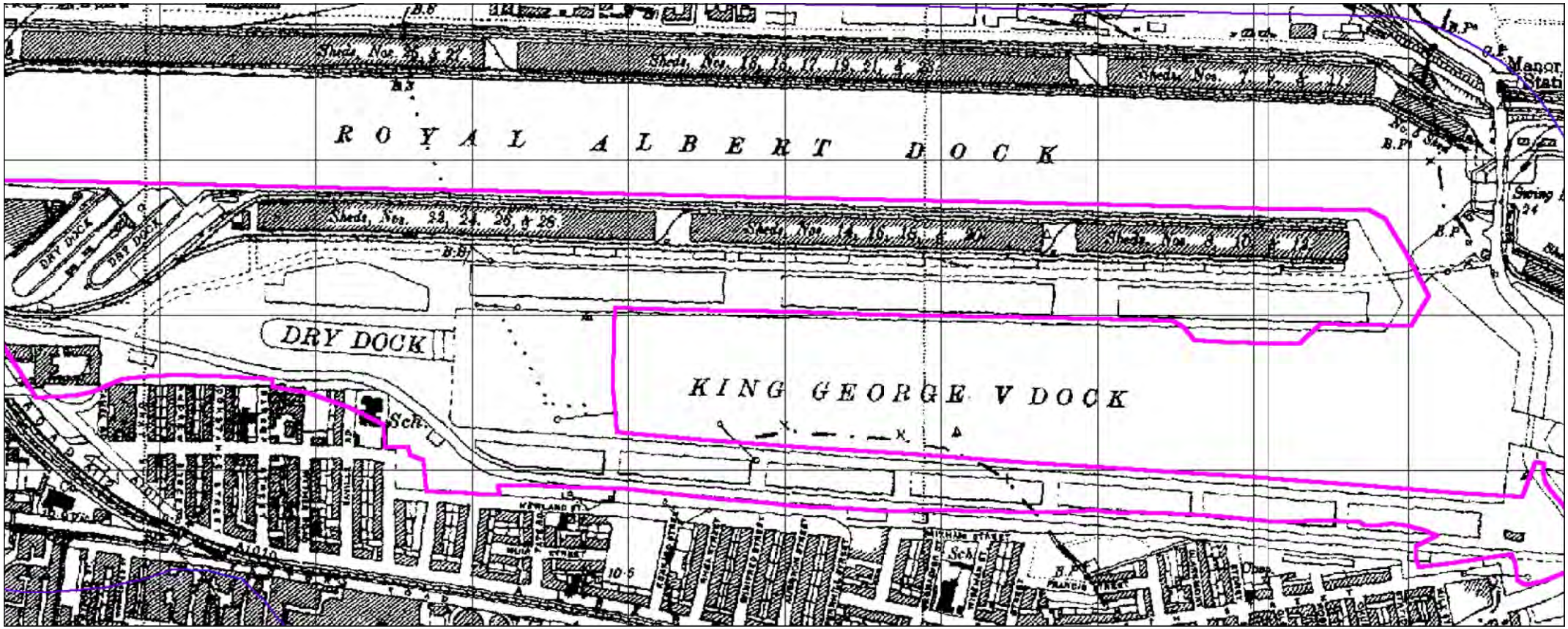
Client: London City Airport
Project: CADP 1
Title: Historical Map Extract - 1896

Date: Oct 2017
Figure: 2

Scale: NTS
Rev: 00



Key:

Wider Airport Site

RPS
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Client: London City Airport
Project: CADP 1
Title: Historical Map Extract - 1938

Date: Oct 2017
Figure: 3

Scale: NTS
Rev: 00