

APPENDIX O

CGL Remediation Scheme Addendum



Clark Smith Partnership

Western Access, Southall

Remediation Scheme Addendum

September, 2017



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Reference	CGN/03732I	Revision	P1	Issue Date July 2017
			C1	October 2017

Contents

1.	INTRODUCTION	4
1.1	Scope of works	4
1.2	Scope of this report	5
2.	SITE SETTING AND CONTEXT	7
2.1	General	7
2.2	Site location	7
2.3	Site description	7
2.4	Proposed development	9
2.5	Summary of historical development	10
2.6	Ground conditions	10
3.	SUMMARY OF CONTAMINATION ASSESSMENT	12
3.1	Previous ground investigation summary	12
3.2	Soils	14
3.3	Leachate	14
3.4	Groundwater	15
3.5	Summary	16
4.	CONCEPTUAL SITE MODEL	17
4.1	Introduction	17
5.	EARTHWORKS STRATEGY	21
5.1	General	21
5.2	Management of environmental aspects during construction	23
6.	CONTROLLED WATERS DQRA AND RE-USE CRITERIA	26
6.1	Introduction	26
6.2	Input parameters	27
6.3	Models	28
6.4	Model outputs – soil re-use criteria	29
6.5	Sensitivity analysis	30
7.	TEMPORARY STOCKPILING	32
7.1	Materials separation and protection	32
7.2	Stockpile contaminant migration appraisal	34
8.	PERMANENT WORKS	35
8.1	General	35
8.2	Highway embankment	35
8.3	Drainage attenuation storage	37
8.4	Materials Management Plan (MMP)	38
8.5	Flood compensation area	38

8.6	Piling risk assessment	38
9.	MONITORING STRATEGY	40
9.1	Introduction	40
9.2	Groundwater and surface water monitoring	40
9.3	Groundwater / surface water and mitigation contingency plan	42
10.	WATCHING BRIEF AND DISCOVERY STRATEGY	45
11.	VERIFICATION	47

FIGURES

- Figure 1 – Site Location Plan
- Figure 2 – Development Overview Plan
- Figure 3 – Site Layout & Exploratory hole location plan
- Figure 4 – Contamination Observation Plan
- Figure 5 – Conceptual Site Model
- Figure 6 – Detention Basin Conceptual Model

APPENDICES

- Appendix A – Earthworks Material Acceptability and Waste Classification reports:
 - A720-E05-IW-BR-CGL-EW-TS-0003 P1
 - A720-E05-IW-BR-CGL-EW-TS-0004 P1
 - A720-E05-IW-BR-CGL-EW-TS-0005 P1
- Appendix B – Groundwater monitoring results
- Appendix C – Proposed earthworks cut and fill volumes
- Appendix D – DQRA input parameter summary
- Appendix E – DQRA model outputs
- Appendix F – Lagoon Temporary Stockpile Appraisal report (A720-E05-IW-CGL-EW-RP-0002 P2)
- Appendix G - Permissible criteria for imported general fill
- Appendix H – Maximum permissible concentrations for imported capping layer soils
- Appendix I – Attenuation storage liner
- Appendix J – Piling risk assessment
- Appendix K – Groundwater monitoring trigger values
- Appendix L – Geoenvironmental Process Charts
- Appendix M – Verification Plan

1. INTRODUCTION

Card Geotechnics Limited (CGL) has been instructed by Clark Smith Partnership, on behalf of FM Conway Limited (FMC), to provide geotechnical and geoenvironmental consultancy services on the Southall Western Access project. The project comprises a new section of road embankment, crossing two watercourses, which will provide access to the Southall Waterside development, an 88-acre mixed regeneration project being delivered by the Berkeley Group.

A site location plan is presented as Figure 1 and a development overview plan is presented as Figure 2.

1.1 Scope of works

As part of the wider Western Access scheme, CGL has been instructed to undertake ground investigation and design in order to produce the following deliverables and provide the associated support in terms of scheme construction and planning condition approvals;

- Geotechnical Design Report (GDR) (*Aconex ref: A720-E05-IW-CGL-EW-RP-0004*);
- GDR Addendum Report (*Aconex ref: A720-E05-IW-CGL-EW-RP-0005*);
- Earthworks Specification (*Aconex ref: A720-E05-IW-CGL-BR-EW-SPC-0001*);
- Materials Management Plan (MMP) (*Aconex ref: A720-E05-IW-CGL-RP-0003*);
- Piling Risk Assessment; and
- Permanent and temporary works support.

The above items incorporate both geotechnical and geoenvironmental aspects and are the subject of their own respective reports. The above deliverables have been produced under the detailed design phase of the scheme and build upon previous reports^{1,2} submitted by CGL under the Pre-Construction Services Agreement (PCSA) phase of works, completed in December 2016.

As a result of consultation throughout the detailed design phase, CGL has been instructed to complete a Remediation Scheme Addendum report in addition to the above

¹ CGL (2016). Southall Western Access – Materials Management Plan. (A720-E05-IW-BR-CGL-EW-TS-0002 P2)

² CGL (2016). Southall Western Access – Outline Geotechnical Design Report. (A720-E05-IW-BR-CGL-EW-TS-0001 P2)

deliverables. This addendum report builds upon the existing Arup Remediation Scheme document³ for the Western Access, which forms the remediation strategy for the project. The Arup Remediation Scheme document has been submitted to the London Borough of Hillingdon and approved through planning under the first phase of development of the Western Access project.

Remediation of the main Southall Waterside development site, located to the east of the Grand Union Canal and incorporating the eastern embankment of the Western Access scheme, is being undertaken by CA Blackwells Limited. A separate remediation strategy for the main Southall Waterside development has been produced by Atkins under London Borough of Ealing planning consents.

1.2 Scope of this report

This report is considered to act as an addendum to the Arup Remediation Scheme document, to incorporate recent aspects of the project development during the detailed design phase. In this respect, the report relates only to the area of the site located within the London Borough of Hillingdon.

The additional aspects, not previously covered by the Remediation Scheme, have been highlighted following ongoing engagement with the Environment Agency, in support of the Western Access development. These additional aspects comprise the following:

- Generation of chemical criteria for re-use of site won materials within the scheme;
- A methodology for managing temporary stockpiling of site-won materials for re-use within the scheme;
- Further information with regards to treatment of site won fill material for re-use within the scheme;
- Establishing a monitoring programme to be adopted pre-, during and post construction of the western access; and
- Confirmation of the supervision and verification to be undertaken during the works including how unexpected contamination will be assessed and addressed.

³ ARUP (2016). Proposed Bridge Works for Southall Gas Works Redevelopment – Remediation Scheme [Issue 6]. Dated 5th August 2016. (A720-E02-PA-ARU-EN-RP-0003 P6)

To provide context and address the above, this report includes the following sections:

- Section 2 – site setting and context including a summary of the proposed Western Access development;
- Section 3 – a summary of the contamination assessment works completed to date;
- Section 4 – confirmation of the scheme conceptual site model;
- Section 5 – a summary of the proposed earthworks strategy;
- Section 6 – a summary of detailed quantitative risk assessment (DQRA) undertaken to derive re-use criteria for the scheme and the DQRA outcomes;
- Section 7 – the proposed methodology for mitigation of new pathways during temporary stockpiling;
- Section 8 - a summary of proposals for elements of the permanent works relating to contaminant pathways and the application of the re-use criteria within the earthworks strategy;
- Section 9 – details of the monitoring programme to be adopted pre-, during- and post-construction;
- Section 10 – a proposed watching brief and discovery strategy in the event of unexpected contamination; and
- Section 11 – confirmation of verification requirements in conjunction with other scheme deliverables.

It is anticipated that this addendum report will be used to obtain agreement from the statutory authorities with regards to the proposed management of contamination risks throughout the temporary and permanent works. It is intended to provide supplementary information to the GDR, MMP and Earthworks Specification, which are referred to throughout this report.

2. SITE SETTING AND CONTEXT

2.1 General

The Western Access scheme will be undertaken by FM Conway Ltd (FM Conway), who will be providing 'design and build' services under contract to Berkeley West Thames (BWT). The above scheme, herein referred to as 'the Site', comprises the construction of two new access bridges, a footbridge foundation and associated carriageway and supporting embankments to link the main Southall Waterside development to the existing Pump Lane carriageway.

Extensive documentation has historically been compiled for this scheme, which contains detail of the site, the proposed development and site geology/hydrogeology. The following sections provided a concise summary of the information contained within previous reports. A summary of historical scheme documentation can be found within the CGL GDR, referenced in Section 1.1.

2.2 Site location

The Site area as a whole covers approximately 7.66Ha. The area encompassing all three permanent earthworks is centred approximately on National Grid Reference (NGR) 511254, 179810.

A site location plan is included as Figure 1.

2.3 Site description

The Site is located within the London Borough of Hillingdon and borders the London Borough of Ealing to the east.

The Site area is roughly rectangular in shape and is bound to the east by the Grand Union Canal with the main Southall Waterside development beyond, the Minet Country Park to the north and the Great Western Mainline to the south. The Site is bound to the west by the existing Pump Lane carriageway, onto which the new Western Access road will connect.

For the purposes of this report, and to align with preceding investigation reports, the Site has been delineated into four main areas lying between the three main watercourses cutting the site; the River Crane, Yeading Brook and the Grand Union Canal (Plate 1).

- Area 1 - The largest area follows the course of the River Crane, oriented roughly south to north east and located east of Pump Lane, towards the Flood Compensation Area. The southernmost portion of this area relates to the proposed western road embankment, located between the River Crane and the Yeading Brook. This also incorporates an area west of the River Crane previously referenced as 'Bridge Bund'.
- Area 2 - The second area of investigation was along the proposed route for the western access road alignment, orientated west to east along the southern area of the site between the Yeading Brook and Grand Union canal. This area relates to the location of the proposed central road embankment.
- Area 3 - The Lagoon Bund is located on the north-eastern boundary of the site, and is located just west of the Grand Union Canal (oriented south west to north east). The Lagoon Bund comprises a roughly circular area of some 83m², and is understood to have been used as a dumping area for dredged materials from the Grand Union Canal.
- Area 4 - The area of the proposed road alignment located to the east of the Grand Union Canal, comprising a small area that lies adjacent to the main Southall Waterside development site.

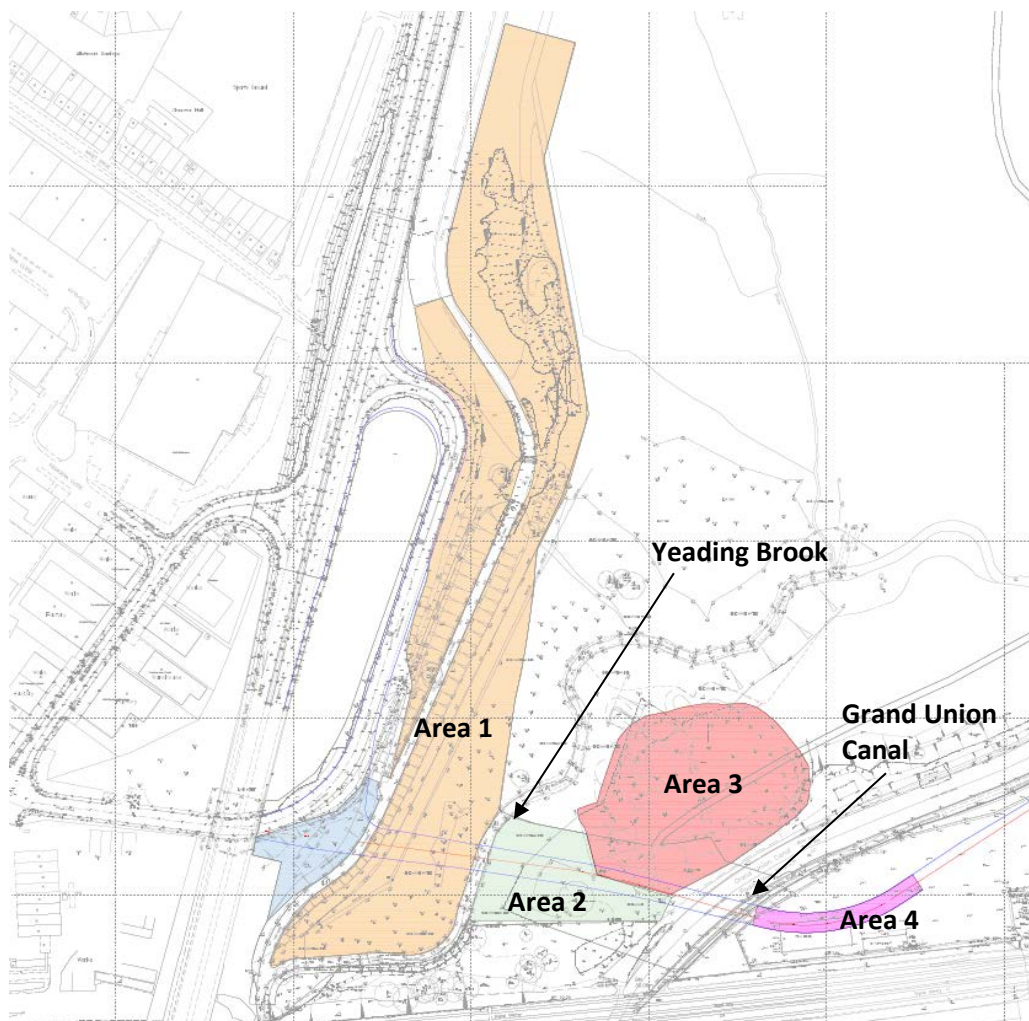


Plate 1 - Site overview

2.4 Proposed development

Planning permission has been granted for the construction of the new accesses to the main Southall Waterside development. The Site represents the construction of three new embankments and two new bridges, crossing the Yeading Brook and the Grand Union Canal. The work will also include the realignment of a flood channel to change where it enters the brook and provide flood compensation storage to offset the flood volume taken up by the road embankments.

The central embankment forming the Western Access will incorporate a section of land take within an area known as the Minet Tip, which will form the northern site boundary. The Minet Tip land is owned by the Canal and River Trust (CRT) and this area has been used for waste tipping of dredged materials from the Grand Union Canal. More recently, earthworks have been created to form lagoons used for canal dredgings. A portion of this land has been acquired by BWT under Compulsory Purchase Order to facilitate the construction of the central embankment.

Following construction of the Western Access embankment, the lagoon needs to be reconfigured in order to maintain the existing capacity for future CRT activities. Currently, the reconfiguration of the lagoon is not within FMC's scope of works for the Western Access scheme and will not be referred to in this report.

2.5 Summary of historical development

The key historical uses of the site and surrounding area are as follows:

- Prior to development the Site formed part of the flood plain and valley side of the Yeading Brook;
- The Grand Union Canal was constructed in the early 19th Century;
- The gasworks (within the main Southall Waterside development) was developed to the east of the canal between the mid 19th century and the end of the century; and
- Tipping started between the canal and the brook in the 1930s and continued until recently. Latterly only canal dredgings have been placed on the Minet Tip.

2.6 Ground conditions

2.6.1 Geology

According to the British Geological Survey (BGS) map of the area⁴, much of the Site is underlain by Made Ground. Along the course of the brook, Alluvium is shown with Lynch Hill Terrace Gravels also present. These are underlain by London Clay and Chalk at depth.

Beyond the immediate valley associated with the brook, the BGS records show the Langley Silt Member to be present.

2.6.2 Hydrogeology and hydrology

According to the Environment Agency website⁵ the site is underlain by a Principal Aquifer (Lynch Hill Gravel Member). These strata usually provide water storage and may also support water supply and/or river base flow.

The underlying London Clay is classified by the EA as an Unproductive Strata. The site is not located within a groundwater water protection zone. The Arup Detailed Quantitative

⁴ BGS (1998). 1:50,000 Series England and Wales Sheet 270, South London, Solid and Drift Geology.

⁵ <http://www.environment-agency.gov.uk/>

Risk Assessment report (DQRA)⁶ mentions that records from the EA indicate there is only one licenced abstraction within 1km of the site, which is located 700m southwest of the site boundary. The abstraction, which is from the Chalk Principal Aquifer, is used for industrial/commercial use.

Three main watercourses cut the site including the River Crane, Yeading Brook and the Grand Union Canal. Both the Grand Union Canal and the River Crane are lined which will afford protection to these water bodies. The Yeading Brook is unlined.

⁶ ARUP (2015). St James West London, Southall Gas Works. *Detailed Quantitative Risk Assessment*. Job number 228263.

3. SUMMARY OF CONTAMINATION ASSESSMENT

3.1 Previous ground investigation summary

Several phases of ground investigation have been undertaken at the Site dating back to 1977. A full summary of the available investigation information is contained within the CGL GDR. This section will introduce and summarise those investigations undertaken by CGL during the 'advanced works' and 'detailed design' phases of the scheme to support the determination of materials suitable for re-use within the earthworks.

A total of 54nr. trials pits were undertaken across three phases of investigation, completed between February and March 2017. The results of each phase of investigation were summarised within an Earthworks Material Acceptability and Waste Characterisation (EMAWC) report^{7,8,9}. The staged undertaking and issue of these individual investigation reports was to provide a continuous release of information and to suit specific design objectives during the separate advanced works and detailed design phases of the scheme.

A summary of the findings within each report is discussed below. A site layout & exploratory hole location plan is presented as Figure 3.

3.1.1 Pump Lane Bund (within Area 1)

Trial pits were undertaken within the soil bund offering the existing boundary between the Site and the Pump Lane carriageway, which exclusively comprised Made Ground. The bund was proposed to be removed as part of the initial enabling works to provide site access and offices.

Geotechnical and chemical testing was undertaken on selected soil samples to determine material suitability for re-use and, if required, disposal off-site. This phase of testing and assessment only comprised screening against criteria for risks to human health, as the potential re-use of the material was not yet determined. No concentrations recorded within the Made Ground exceeded the assessment criteria.

⁷ CGL (2017). *CGN/03732C Southall advanced works*. Earthworks material acceptability and waste characterisation - Pump Lane Bund. Rev1. May 2017

⁸ CGL (2017). *CGN/03732D Southall advanced works*. Earthworks material acceptability and waste characterisation - Bridge Bund and Lagoon Bund. Rev1. May 2017

⁹ CGL (2017). *CGN/03732E Southall Western Access*. Earthworks material acceptability and waste characterisation - Western Access Site. Rev0. May 2017

No assessment against criteria for risks to controlled waters was undertaken during this phase of investigation. Full details of the assessment and recorded exceedances are shown within the relevant EMAWC report contained within Appendix A (report ref: A720-E05-IW-BR-CGL-EW-TS-0003 P1).

3.1.2 Bridge Bund (Area 1) and Lagoon Bund (Area 3)

Trial pits were undertaken at two locations within the Site. The 'Bridge Bund' was an existing stockpile of material forming a further boundary between the Site and the Pump Lane carriageway. The stockpile, comprising exclusively Made Ground, was proposed to be excavated to permit the construction of a temporary bridge across the Yeading Brook.

The 'Lagoon Bund', which has been described earlier in the report, was primarily investigated to determine initial geotechnical parameters for the potential re-use of this material within the earthworks.

The results of the investigation showed that no concentrations within the Bridge Bund or Lagoon Bund exceeded the assessment criteria for risks to human health. However, waste acceptance criteria (WAC) assessment indicated the material would be deemed hazardous due to elevated TPH concentrations, with a single sample exceeding the hazardous waste landfill criteria.

No assessment against criteria for risks to controlled waters was undertaken during this phase of investigation. Full details of the assessment and recorded exceedances are shown with the relevant EMAWC report contained within Appendix A (report ref: A720-E05-IW-BR-CGL-EW-TS-0004 P1).

3.1.3 Western Access Site (incorporating Area 1-4)

This round of investigation was undertaken within the detailed design phase of the scheme. The number and location of trial pits was increased to obtain coverage of the likely source materials throughout the entire Site. Based on the results of the advanced works round of investigations, additional trial pits were focused on areas where contaminant concentrations were expected to be elevated i.e. the Lagoon Bund.

Samples taken from the River Crane (Area 1), the central embankment (Area 2) and the Lagoon Bund (Area 3), were tested against screening criteria for risks to controlled waters. The results of the investigation showed that all eight samples tested exceeded the Freshwater EQS screening criteria for certain contaminants including; sulfates, total

phenols, metals, PAH and pH. In addition, six metals and one PAH exceeded the DWV criteria, however this is considered to be a less preferential criteria than the EQS values. Full details of the assessment and recorded exceedances are shown with the relevant EMAWC report contained within Appendix A (report ref: A720-E05-IW-BR-CGL-EW-TS-0005 P1).

3.2 Soils

The results of soils analysis from the three phases of investigation completed between February and March 2017 were screened against UK generic assessment criteria (GAC) for a commercial land use, which were originally adopted as the 'limiting values' in accordance with Appendix 6/15 of the Preliminary Geotechnical Design Report. A commercial land use was considered a reasonably conservative initial assessment given the end use of the site as an access road with associated landscaping. The assessment did not identify any exceedances of commercial GAC within either Made Ground or natural strata though asbestos fibres were identified within six Made Ground samples, from laboratory analysis, at quantities, where recorded, below laboratory detection limits (<0.001% by volume).

Observations of contamination on site were recorded within a couple of Made Ground samples within Area 3, the lagoon bund. This included a layer of spent oxide ('Blue Billy') identified within TP29C at approximately 1.3m bgl and a number of hydrocarbon odours within the lagoon area. Whilst none of the results exceeded the GACs, the analysis from samples within the lagoon bund (Area 3) were found to contain the most elevated concentrations of contaminants.

3.3 Leachate

Leachate data was obtained from eight Made Ground / topsoil samples from the third phase of investigation in March 2017. These samples were obtained from the central embankment (Area 2), one from the River Crane (Area 1) and the remainder from the Lagoon Bund (Area 3). The results were compared with freshwater Environmental Quality Standards (EQS) and Drinking Water Values (DWV), as reasonably conservative screening values and based on the Yeading Brook forming the principal controlled waters receptor. These GAC were adopted as limiting values within Appendix 6/14 of the Preliminary Geotechnical Design Report.

Exceedances of the GAC were recorded within all eight samples with those samples from the Lagoon Bund found to have the highest concentrations. Exceedances in the Lagoon Bund included metals / metalloids, poly—cyclic aromatic hydrocarbons (PAHs), total

phenols, sulfate and pH. Generally, the highest concentrations were recorded within the leachate analysed from the spent oxide soil sample from TP29C.

Similar contaminants of concern were recorded within the three samples collected from the central embankment (Area 3) though concentrations were lower than in the samples from the Lagoon Bund. The leachate sample from the River Crane section (Area 1) was only found to exceed the GAC for a single contaminant; lead.

3.4 Groundwater

Two rounds of initial baseline monitoring and sampling of boreholes, installed to monitor the western access construction activities, was undertaken over the course of June 2017. Groundwater levels recorded during the monitoring rounds are summarised in Table 1. In-situ test results are presented in Appendix B. Samples were obtained from five monitoring locations, three from within the Lagoon (BH1A to BH3A) and two locations outside and nominally up-gradient of the Lagoon (BH3B and BH4B). A further two down-gradient monitoring locations, between the Lagoon and Yeading Brook (BH1B and BH2B), were installed between the 21st and 22nd June 2017 using restricted access drilling equipment. Pre-construction monitoring of these boreholes has not yet been undertaken, so as to enable the boreholes to settle following installation.

Table 1 Summary of groundwater levels

Borehole	Well response zone	Water strike (mbgl)	Water level 1 st Round 2 nd June 2017 (mbgl)	Water level 2 nd Round 27 th June 2017 (mbgl)
BH1A	Lynch Hill Gravel	Dry	2.45	2.55
BH2A	Made Ground	Dry	0.98	1.09
BH3A	Lynch Hill Gravel	Dry	1.16	1.55
BH1B	Lynch Hill Gravel	Dry	-	DRY
BH2B	Lynch Hill Gravel	Dry	-	DRY
BH3B	Lynch Hill Gravel	Dry	1.22	1.44
BH4B	Lynch Hill Gravel	Dry	0.45	0.57

Laboratory results were screened against freshwater EQS and DWV with exceedances recorded for certain metals (cadmium, boron and lead), free ammonia, PAHs (anthracene, fluoranthene and benzo(a)pyrene) and sulfate.

Further intrusive investigation, comprising borehole installation and monitoring was undertaken by Ramboll Environ, on behalf of FM Conway in April 2017. Three borehole locations were installed within the area of the western access to enable baseline, construction and post construction monitoring. The findings of the investigation including soils and initial groundwater monitoring results were presented in Ramboll Environ's Baseline Site Investigation Report (dated 19th May 2017) which concluded that the investigation did *'not identify field observations of significant contamination in soils or groundwater. Putrescible or unusual fill materials were not encountered. Ramboll Environ considers that the site investigation works have not identified significant or unexpected contamination.'*

3.5 Summary

The results of the investigation phase have identified some specific areas of the site where contamination is expected to be encountered. A contamination observation plan is presented as Figure 4, which highlights these areas and the contaminants of concern. Soil contaminants have been shown to be below the conservative screening criteria for risks to human health. Leachable contaminants have been shown to exceed initial screening criteria relevant to controlled waters. Groundwater contamination from pre-construction monitoring rounds has been shown to exceed conservative controlled waters screening criteria for some contaminants.

4. CONCEPTUAL SITE MODEL

4.1 Introduction

Previous phases of conceptual site model development and risk assessment have been completed for the Western Access site by Arup^{10, 11}. These concluded that no relevant pollutant linkages exist for the proposed Western Access Scheme and that risks can be managed through appropriate design and construction control measures. Based on these risk assessments, Arup concluded that remediation of the scheme was not required, as unacceptable risks to receptors were not identified.

Subsequent to these assessments the design of the Western Access has progressed and ongoing liaison with the regulators, principally the Environment Agency, has identified further aspects that require consideration, as noted above. As part of the design works additional ground investigation data has been obtained (and continues to be obtained) which has enabled refinement of the CSM and risk assessment. Based on these additional works and the previous Arup assessment a refined CSM and semi-quantitative risk assessment for the final, constructed scheme, is presented below.

The assessment has been undertaken in accordance with Contaminated Land Report (CLR) 11¹². The risks identified are in accordance with the DEFRA and Contaminated Land Report (CLR) 6¹³, site prioritisation and categorisation rating system which is summarised in Table 2 below.

Table 2 - Risk Rating Terminology

Risk Rating	Description
High Risk	Contaminants very likely to represent an unacceptable risk to identified targets Site probably not suitable for proposed use Enforcement action possible, Urgent action required
Medium Risk	Contaminants likely to represent an unacceptable risk to identified targets Site probably not suitable for proposed use

¹⁰ Ove Arup & Partners Ltd (18 February October 2015) St James West London Limited, Proposed Pump Lane Access, Works for Southall Gas Works, Redevelopment
Ground Investigation Report,

¹¹ Ove Arup & Partners Ltd (01 October 2015) St James West London, Proposed Bridge Works for Southall Gas Works Redevelopment, Ground Contamination: Detailed Quantitative Risk Assessment, Issue 2, Job No. 228263.

¹² The Environment Agency (2004) Model Procedures for the Management of Land Contamination, CLR 11

¹³ M.J. Carter Associates (1995) Prioritisation and Categorisation Procedure for Sites which may be Contaminated, Department of the Environment, CLR 6

	Action required in the medium term
Low Risk	Contaminants may be present but unlikely to create unacceptable risk to identified targets Site probably suitable for proposed use Action unlikely to be needed whilst site remains in current use
Negligible Risk	If contamination sources are present they are considered to be minor in nature and extent Site suitable for proposed use No further action required

The risk assessment is provided below in Table 3.

Table 3 - Semi-quantitative Risk Assessment

Source/Medium	Receptor	Potential Exposure Route	Risk Rating
Explosive / asphyxiating gases from within Made Ground and Lagoon deposits.	Future users	Migration of gases through the surface and via permeable soils, and subsequent inhalation in outdoor air.	Negligible <i>(Arup report Characteristic Situation 2 or low risk but no enclosed spaces proposed in development)</i>
	Embankment & bridge structures & services	Migration of gases through the surface and via permeable soils.	Negligible <i>(Risk of gas build-up and impact on structures is negligible as no enclosed spaces)</i>
	Construction workers	Migration of gases through the surface and via permeable soils, and subsequent inhalation.	Low <i>(Appropriate health and safety protocols and management during construction works)</i>
Contaminants in soils within flood compensation area and Lagoon Bund to be used in embankment construction	Future users, maintenance workers & trespassers	Direct contact & ingestion of soils, vapours and soil derived dust	Low <i>(Materials used will be effectively encapsulated within the embankment and under the road pavement construction minimising direct contact / dust pathways. GAC assessment does not indicate a risk to human health from vapours)</i>
	Buildings, structures & services	Direct contact	Low <i>(Elevated sulfate concentrations in soils and water to be mitigated through appropriate concrete / pile design)</i>
	Off-site occupants	Inhalation of vapours and soil derived dust	Negligible / low <i>(Post construction risk is considered negligible following placement and stabilisation of fill. Site control measures to be adopted to minimise risks during construction)</i>

Source/Medium	Receptor	Potential Exposure Route	Risk Rating
	Construction workers	Direct contact, ingestion, vapour inhalation and soil derived dust	Low to medium <i>(Appropriate health and safety protocols and personal/respiratory protective equipment required)</i>
	Plants and vegetation	Uptake via roots	Low to medium <i>(Capping layer and growth medium likely required where new vegetation proposed e.g. sides of the embankment)</i>
	Groundwater within the Lynch Hill Gravel	Leaching from soils to groundwater	Low to medium <i>(Potential ongoing impact to be mitigated by use of material meeting scheme re-use criteria and through appropriate design to mitigate risks associated with new pathways e.g. management of temporary stockpiles)</i>
	Groundwater within deep aquifer (Chalk)	Leaching and migration of contaminants	Negligible <i>(Groundwater in the deep Chalk aquifer protected by the overlying London Clay Formation ~30m thick)</i>
	Yeading Brook	Leaching and lateral migration of contaminants	Medium <i>(Design measures to minimise potential impact include lining the proposed temporary lagoon stockpiles, re-use of material to meet modelled criteria and treatment / stabilisation of certain materials which will reduce permeability)</i>
	Grand Union Canal	Leaching and lateral migration of contaminants	Negligible <i>(Canal is lined and not considered in hydraulic continuity with the site)</i>
Dissolved phase contamination within the Lynch Hill Gravel groundwater	Construction workers	Dermal contact and potential ingestion of contaminated shallow groundwater	Low <i>(Appropriate health and safety protocols required)</i>
	Yeading Brook	Lateral migration of contaminants in groundwater	Medium <i>(Design measures to minimise impact including lining temporary lagoon stockpile, re-use of suitable materials and stabilisation to treat residual dissolved phase metals contamination)</i>
	Grand Union Canal	Lateral migration of contaminants in groundwater	Negligible <i>(Canal is lined and not considered in hydraulic continuity with the site)</i>

Source/Medium	Receptor	Potential Exposure Route	Risk Rating
	Buildings, structures & services	Direct contact	Low <i>(Elevated sulfate concentrations in water to be mitigated through appropriate concrete / pile design)</i>

A simplified pictorial representation of the conceptual site model for the scheme is presented as Figure 5.

5. EARTHWORKS STRATEGY

5.1 General

The construction phase of the scheme will involve the excavation, movement, placement and compaction of fill to form three new embankments. Material excavated from source areas within the Site (e.g. Flood Compensation Area, Lagoon Bund) are proposed to be re-used within the earthwork. There is currently expected to be a net deficit of fill material, based upon the latest assessment of cut/fill volumes. Details of the proposed cut and fill areas are shown within Appendix C and summarised in Table 4 below.

An estimation of the proportion of directly re-useable cut material has been made based upon proposed formation levels, anticipated ground conditions and outline chemical soil results. Based on this estimate, an adjusted cut volume is calculated. This indicates a net fill of approximately 32,000m³, however this value may change depending on the variability of ground conditions encountered at excavation and presence of contamination and should be used as an estimation of anticipated fill volumes.

Table 4 Summary of cut/fill volumes

Zone	Location	Cut (m ³) ^a	Fill (m ³) ^b	Net (m ³) ^c	Estimated % re-use ^d	Adjusted cut (m ³) ^e	Adjusted Net (m ³)
1	Flood Compensation Area	20,527.0	6,770.7	-13,756.3	85%	17,448.0	-10,677.3
2	Diverted channel (River Crane)	3,010.0	1,200.3	-1,809.7	75%	2,257.5	-1,057.2
3	Pump Lane Junction	4,608.0	7,668.1	3,060.1	50%	2,304.0	5,364.1
3A	River Crane infilled channel (South)	0.0	892.0	892.0	0%	0.0	892.0
4	Central Embankment	9,963.6	16,465.0	6,501.4	25%	2,490.9	13,974.1
5	East of Grand Union Canal	1,347.7	10,755.3	9,407.6	75%	1,010.8	9,744.5
6	Detention Basin	912.4	1,036.5	124.1	50%	456.2	580.3
7	Western Embankment	1,622.4	6,199.2	4,576.8	75%	1,216.8	4,982.4
8	River Crane infilled channel (North)	1,025.1	2,896.1	1,871.0	50%	512.6	2,383.6
9	Pump Lane Bund	12,965.7	10,123.5	-2,842.2	40%	5,186.3	4,937.2
10	Pump Lane PRI	6,585.4	5,476.3	-1,109.1	75%	4,939.1	537.3
	Total (m³)	62,567.3	69,483.0	6,915.7		37,822.0	31,661.0

- a) Based upon gross cut from existing level to formation level (REF: A720-E05-IW-CCE-EW-DR-0610 P6)
- b) Based upon gross fill from existing level to formation level plus net fill from formation level to proposed design level (REF: A720-E05-IW-CCE-EW-DR-0600 P5) accounting for proposed pavement volumes.
- c) Positive (+ve) values indicate fill required. Negative (-ve) values indicate surplus cut. Values assume 100% reuse of cut material.
- d) Percentage based upon direct re-use without treatment.
- e) Cut volumes adjusted for estimated percentage of direct re-use.

The results of the recent rounds of investigation, discussed in Section 3, have shown that certain of the material, predominantly within the Lagoon Bund, has highly variable and unsuitable geotechnical properties. In order to render this source material suitable for re-use, improvement using lime was proposed during the design phase. Initial laboratory trials identified a combined lime and Ground Granulated Blast-furnace Slag (GGBS) treatment approach would obtain the necessary geotechnical parameters, when applied to a blended 'host' material. A source material comprised of approximately 40% Made Ground from the Lagoon Bund and 60% Made Ground/natural material from other areas within the Site was proposed. Following further design discussions and due to the programme constraints, the current proposal is not to undertake wholesale stabilisation of unsuitable site won material and to instead import material to make up the required balance. However, if the project requirements change, site won material may be stabilised as part of the works to meet the geotechnical and geoenvironmental parameters for material re-use. It should be noted that if site won material is stabilised the binding agents used may not be the same lime and GGBS mix used in the bench trials and further trials will be required, alongside consultation with the regulators, to agree suitability of materials and obtain the necessary treatment permits. Unsuitable materials encountered during the earthworks which are not stabilised for re-use will be tested and classified for either off-site re-use / treatment or disposal to a suitably licensed facility.

For those materials deemed suitable for re-use and for general storage of materials, it is proposed to utilise the Minet Tip lagoon area as a temporary stockpiling location, due to the limited working area within the Site. Further discussion on the temporary stockpiling is contained within Section 8.

A summary of the key construction activities include:

- Flood Compensation Area;
- River Crane diversion;
- the installation of CFA piles and pile caps to support the permanent bridges;
- the construction of bridge abutments and associated wing walls;
- material excavation, stockpiling and treatment;
- embankment filling and compaction; and

- final road construction.

5.2 Management of environmental aspects during construction

Development of the design beyond the PCSA phase has resulted in additional data becoming available, which has permitted those previously submitted reports to be updated as part of the detailed design phase. As outlined in Section 1, this report relates specifically to the environmental aspects of the construction, with risks to controlled waters representing the key assessment criteria.

Consultation with the Environment Agency during the detailed design phase meetings has revealed specific concerns with respect to the creation of contaminant pathways as a result of proposed construction activities. In summary, the concerns raised are:

- Definition of the upper limit criteria for re-use of material to prevent contamination to water courses;
- Clarification of the lining material proposed for the flood compensation area;
- Clarification of the lining material proposed for the highway drainage attenuation storage;
- Clarification of the outline 'clay tank' detail at the base of the earthworks;
- Consideration of seasonal groundwater levels;
- Clarification of measures to mitigate leachate from temporarily stockpiled materials;
- Confirmation of no adverse impact on pathways as result of surcharge from temporary stockpiling;
- Clarification of the protection measures proposed for the temporary stockpile;
- Definition of groundwater monitoring strategy throughout the construction activities and into service; and
- Definition of proposed discovery strategy in the event of unforeseen contamination;

The result of the investigations undertaken (Section 3) and the issues raised above, combined with the project objective to reduce material import, has led to the requirement to assess whether site specific re-use criteria may benefit the scheme whilst providing the necessary protection to controlled waters.

The following sections introduce the basis of a Detailed Quantitative Risk Assessment undertaken to determine re-use criteria based upon the site specific data gathered during the investigations. These sections then demonstrate screening of sampled source material against the derived re-use criteria and outlines the strategy by which material will be screened throughout the construction.

The derived re-use criteria are then presented alongside additional mitigation measures to minimise the risks from temporary stockpiling of materials and the long term risks associated with the stabilisation of materials for use within the embankment.

Generally, the process that has been adopted to manage the environmental risks, which is presented across the sections within this report, is as follows;

1. Determine extent and location of soils contamination through preliminary investigations.
2. Screen sampled materials against Generic Assessment Criteria.
3. Undertake DQRA to determine site-specific re-use criteria for risks to controlled waters.
4. Screen sampled materials against derived re-use criteria.
5. Install up- and down gradient groundwater monitoring installations.
6. Undertake baseline groundwater monitoring (pre-construction).
7. Install stockpile protection measures.
8. Excavate site won soils and stockpile and test materials within the temporary lagoon bund stockpile area.
9. Construct embankment in accordance with Earthworks Specification and associated testing.

10. Observe watching brief throughout construction to identify possible unforeseen contamination.
11. Undertake construction phase groundwater monitoring.
12. Submit verification report including all chemical testing of earthworks materials against derived re-use criteria and, if required, details of validation of unforeseen contamination.
13. Undertake post-construction monitoring.

6. CONTROLLED WATERS DQRA AND RE-USE CRITERIA

6.1 Introduction

A controlled water's detailed quantitative risk assessment (DQRA) has been undertaken for the Western Access site in order to derive site-specific reuse criteria with regard to the protection of controlled waters. It is proposed to reuse site-won material on site as engineered fill within the proposed embankments.

The principal controlled waters receptor is considered to be the Yeading Brook. The selected compliance point is the approximate distance between the soils placed within the embankment, behind the constructed bridge abutments, and the Yeading Brook which is considered to be approximately 15m distance.

6.1.1 Methodology

The risk assessment has been undertaken using the Environment Agency's Remedial Targets Methodology (RTM)¹⁴, in accordance with the Remedial Targets Worksheets¹⁵ and User Manual¹⁶. RTM is a Microsoft Excel based groundwater modelling package, which allows the assessment of the potential risks to controlled waters from contamination in soils and within the groundwater.

The assessment package is split into three Levels, each Level is progressive and the step to the next Level should only be undertaken if a potential risk is identified. The three levels within the model are:

- **Level 1:** Leaching: This level assesses the leaching potential of contamination within soils and its ability to be taken into solution. This assessment provides a measure of the contamination source; remedial targets in Level 1 are derived using the appropriate water quality standard. As a result, a Level 1 assessment is highly conservative as it does not consider retardation or degradation that may occur as the leachate moves through the soil profile.
- **Level 2:** Dilution: Level 2 looks at the effects of dilution and dispersion within groundwater, once contamination reaches the water table. The model does not

¹⁴ Environment Agency (2006). *Remedial Targets Methodology: Hydrogeological Risk Assessment for Land Contamination*.

¹⁵ Environment Agency (January 2013). *Hydrogeological Risk Assessment for Land Contamination; Remedial Targets Worksheets*. Release 3.2.

¹⁶ Environment Agency (October 2006). *Remedial Targets Worksheet v3.1: User Manual. Hydrogeological Risk Assessment for Land Contamination*.

account for an unsaturated zone and assumes that the contamination is located immediately above the groundwater table.

- **Level 3:** Dispersion: Level 3 models the movement of contamination through the aquifer to a compliance point; it takes into consideration the dispersion of contamination through the movement of groundwater and can accommodate factors such as biodegradation. As a contaminant disperses, so the overall concentration in groundwater will reduce, which will in turn reduce the risk to the wider down gradient receptor.

6.2 Input parameters

Site specific data has been used where possible. However, where this is not available, data from published sources have been used. A list of the parameters used in the modelling, and justifications for the parameters, is provided in Appendix D. The main sources of the input parameters (K_d , K , etc.) are summarised as follows:

- Arup (2015). St James West London, Southall Gas Works. *Detailed Quantitative Risk Assessment*. Job number 228263.
- Golders Associates (2003). *ConSim*. Version 2.5. Technical reference file. Environment Agency.
- Vorhees et al (1999). *Human health risk based evaluation of petroleum release sites: Implementing the working group approach*. Total Petroleum Hydrocarbon Working Group Series Volume 5.
- Barnes (2010). *Soil Mechanics, Principles and practice*. Third Edition.
- Berry and Reid (1987). *An Introduction to Soil Mechanics*. Department of Civil Engineering University of Salford.
- Howard et al (1991). *Handbook of Environmental Degradation Rates*. Lewis Publishers. London.
- McWhorter and Sunada (2010). *Groundwater Hydrology and Hydraulics*. Water Resources Publications, Colorado.
- CL:AIRE (2017). *Petroleum Hydrocarbons in Groundwater: Guidance on assessing petroleum hydrocarbons using existing hydrogeological risk assessment methodologies*.

The background concentrations within the aquifer have been set to zero. This enables the contribution from contamination on the site to be assessed without interference from the surrounding area.

Given the Yeading Brook is a freshwater body, the Freshwater Environmental Quality Standard (EQS) have been used in the assessment of the risk to the compliance point.

6.3 Models

6.3.1 Contaminants of concern

Comparison of the leachate results from the CGL investigation to the (EQS) values indicate that the following contaminants exceeded the assessment criteria:

- Metals including, cadmium, chromium VI, lead and mercury;
- Free cyanide and total ammonia;
- PAHs including benzo(a)pyrene and naphthalene;
- Benzene; and
- Phenol.

6.3.2 Source area

The site investigation data indicates that the elevated concentrations of contaminants in the Made Ground occur in a series of discrete source areas and hotspots. The assessment has assumed a source width and length of 10m x 10m for these discrete hotspots.

6.3.3 Hydraulic gradient and hydraulic conductivity

The hydraulic gradient for the aquifer beneath the site has been calculated using monitoring data collected from the site in June 2017.

The hydraulic gradient was calculated from the change in groundwater head between boreholes BH1A, BH3A, BH3B and BH4B.

The hydraulic conductivity for the coarse grained Lynch Hill Gravel Deposits has been based on particle size distribution (PSD) test data from site samples which is similar to published data for gravels.

6.3.4 Saturated aquifer thickness

The saturated aquifer thickness has been modelled as 3.8m, which is based on the potential thickness of the groundwater in the coarse grained Lynch Hill Gravel Deposits recorded during CGL monitoring works.

6.3.5 Degradation rates

The models have been constructed assuming that anaerobic biodegradation is occurring in the Lynch Hill Gravel aquifer. This has been based on recorded redox measurements by CGL ranging from 141V to -114mV in the Lynch Hill Gravel aquifer indicating that biodegradation is occurring under mildly reducing conditions (+50mV to -150mV).

6.3.6 Attenuation/retardation

The models have been constructed assuming that attenuation/retardation is occurring in the Lynch Hill Gravels.

6.3.7 Compliance point

An initial conservative 15m compliance point has been used based on the estimated distance from the soil fill within the embankment, to Yeading Brook, to assess potential risk from dissolved phase contaminants beneath the site. This is considered to be conservative given there are no identified active groundwater or surface water abstractions located close to the site and in consideration of the industrial history of the surrounding area.

6.4 Model outputs – soil re-use criteria

The results of the modelling are presented in Table 5, below. The models have been constructed to allow derivation of re-use criteria for site-won material with regard to the protection of controlled waters. The models are also included in Appendix E.

Table 5. Soil Re-use Criteria

Contaminant	Environmental Quality Standard Value (mg/l)	Level 3 Soil Re-use Criteria (mg/kg) [mg/l]
Total Ammonia	0.6	161 [120]
Benzene	0.01	2.22 [2.01]
Benzo(a)pyrene	0.00002	12.96 [0.004]

Contaminant	Environmental Quality Standard Value (mg/l)	Level 3 Soil Re-use Criteria (mg/kg) [mg/l]
Cadmium	0.00025	12.05 [0.050]
Chromium VI	0.0034	23.99 [0.683]
Free Cyanide	0.001	0.085 (0.5)* [0.212]
Lead	0.0012	1,050.5 [0.241]
Mercury	0.00007	7.03 [0.0141]
Naphthalene	0.002	13.03 [0.403]
Phenol	0.0077	1.32 [1.59]

Note: * Free cyanide re-use criteria limited by the limit of detection of commercially available laboratories and has been set at 0.5mg/kg

6.5 Sensitivity analysis

A sensitivity analysis was undertaken on selected parameters. These parameters included: bulk density, fraction of organic carbon (FOC), effective porosity, hydraulic gradient, hydraulic conductivity, partition coefficient and half-life.

Although some fluctuations occurred by varying the bulk density, FOC and effective porosity, generally no significant change to the remedial target was seen when using the different values available and the most conservative, or average values were used as appropriate.

Using a lower hydraulic gradient and hydraulic conductivity value in the model generally resulted in lower remedial target concentrations, however the average value is considered to be more representative of the site.

A sensitivity analysis was also undertaken on the benzene and benzo(a)pyrene models by varying the partition coefficient and half-life parameters. The sensitivity analysis shows that the lower partition coefficient values, which were used in the assessment, gives more conservative remedial target values. The sensitivity analysis for half-life shows that the higher value used in the model gives more conservative targets.

Overall, it is considered that the model outputs to be sufficiently realistic based on the inputs used in the models.

7. TEMPORARY STOCKPILING

To facilitate the construction of the Western Access embankment it is proposed to temporarily stockpile materials won from source areas across the site within the Minet Tip lagoon, prior to their re-use in the permanent embankment. The following section relates to the proposed temporary stockpiling works and aims to summarise the outcomes of an earlier interim report, which was produced to address;

- *Clarification of measures to mitigate leachate from temporarily stockpiled materials;* (Section 7.1)
- *Confirmation of no adverse impact on pathways as result of surcharge from temporary stockpiling;* (Section 7.2)

The summary contained below repeats the outcomes of the previous interim report, but is presented within the context of the additional information provided as part of this wider remediation strategy addendum. The interim report, which is presented in Appendix F, was previously issued to obtain necessary statutory approvals throughout the design phase and should be read in conjunction with this report to provide additional detail.

7.1 Materials separation and protection

7.1.1 *Proposed stockpile material and potential risks*

The materials that are proposed to be stockpiled within the lagoon comprise Made Ground, fine-grained and coarse-grained Lynch Hill Gravels from source areas including the existing lagoon, the flood alleviation area and the proposed embankment alignment.

Made Ground within the lagoon is recorded to have elevated contaminant concentrations (including TPH and PAH), which are detailed further in Section 2 of this report. However, the majority of material to be stockpiled is anticipated to be sourced from the flood alleviation area, which is shown to have lower contaminant concentrations than those recorded at the lagoon.

The Yeading Brook presents a key receptor that could potentially be impacted by temporary stockpiling. The brook is located down gradient of groundwater flow from the lagoon area, which is understood to run in a southeast to northwest direction. Ground conditions beneath this area comprise fine-grained Lynch Hill Gravel with interrupted lenses of coarse-grained Lynch Hill Gravel.

The potential risk is for infiltration of rainwater through the stockpiled material creating contaminated leachate that could enter the groundwater regime beneath the stockpile.

7.1.2 Lagoon stockpile detail and design

An options appraisal was undertaken to determine possible mitigation solutions that incorporated combinations of impermeable liner, stabilised soils and granular platforms combined with a monitoring strategy.

Full detail of the proposals are presented in Appendix F, which incorporates the temporary stockpile liner schematic (Drawing: A720-E05-IW-CGL-EW-DR-0001). The proposed solution comprises the steps summarised below;

- Placement of a geotextile separation layer (permeable) on top the existing lagoon floor;
- Light compaction of site-won material from the Pump Lane bund or flood alleviation zone to raise levels and create cross-fall;
- Installation of impermeable basal liner geomembrane placed over sand bedding or protective fleece;
- Formation of perimeter swales to allow collection of water runoff across stockpile area;
- Infill of swales and liner area with a granular material to form a drainage blanket;
- Construction of leachate collection system with perimeter pipework and pumping points; and
- Groundwater monitoring at external well locations throughout the stockpiling period.

7.1.3 Post-stockpile conditions

As discussed in Section 2.4, following completion of the stockpiling activities, current proposals are for the lagoon to be permanently reconfigured. These proposals are outside the scope of this report, however the temporary stockpile solution has been developed to allow the lagoon to be easily reinstated to existing condition prior to any reconfiguration works.

7.2 Stockpile contaminant migration appraisal

An appraisal of the potential for mobilisation of contaminants as a result of surcharge load from the temporary stockpile has been undertaken within the above interim report and can be found within Appendix F.

The following is an extract from the report, which clarifies the risk from surcharge loading;

Interpretation of the ground and groundwater conditions at beneath the Lagoon Bund area indicates that, should new contamination pathways be created due to the loading of the existing ground, then the risk to downstream controlled waters from contaminants migrating within groundwater is considered to be low.

The relatively impermeable nature of the cohesive Made Ground, Alluvium and cohesive River Terrace Deposits restrict the migration of potential contaminants. In addition, the granular River Terrace Deposits, where migration of contaminants could readily occur, are not continuous beneath the site. Similarly, the groundwater encountered in the Alluvium is not considered to be laterally pervasive and it is considered unlikely that increased contaminant migration to downstream controlled waters receptors would occur.

8. PERMANENT WORKS

8.1 General

The following section is intended to provide a summary of key aspects, raised in consultation with statutory authorities, with respect to the risks posed to controlled waters from elements of the permanent works.

8.2 Highway embankment

As discussed within Section 5.1, the three permanent embankments will be constructed using site won materials as well as imported fill. The original scheme proposals included a 'clay stank' detail for the base of the embankment, comprising a layer of low permeability material. It is understood that this was specified due to the potential for the embankment to be constructed using granular fill materials that could provide a preferential pathway for contaminants to migrate towards surface water receptors. It can be shown, using the source-pathway-receptor principle, that the current scheme proposals do not pose a significant risk that would require this specific 'clay stank' detail to be retained.

Investigation of the materials found on the site during scheme development has shown a predominance of cohesive soils, with much of the anticipated fill material being classified as a Class 2A or 2C cohesive fill. In addition, treatment of the blended 'host' materials, where undertaken, would likely achieve a Class 9E cohesive stabilised fill. The proposed earthworks strategy will involve the placement and compaction of this fill material onto a predominantly cohesive formation comprised of Alluvium or River Terrace Deposits. As a result, it is considered unlikely that significant additional preferential pathways will be present along the length of the embankment formation and mobilisation of contaminants would be restricted.

8.2.1 Materials testing

The Earthworks Specification includes the requirement for fill materials to be tested against a suite of determinands relevant to pollution of controlled waters and human health. For site-won materials to be re-used within the scheme the principal risk driver has been established as the risk to the water courses on site, predominantly the Yeading Brook. The DQRA in Section 6 of this report sets out the agreed modelled re-use criteria for site-won fill which are protective of these controlled waters. Re-used materials within the scheme are, therefore, required to meet these criteria. Where material does not meet the criteria it will either be treated to render it suitable, for example via stabilisation or

removed from site either for recovery / treatment or for suitable disposal at a licensed facility.

Testing of materials against the re-use criteria will either be undertaken at the point of origin within the scheme (pre-classified), on material temporarily stockpiled within the lagoon area and/or on the treated fill. Testing frequencies will be as detailed within the Earthworks Specification, though will generally be undertaken on the basis of a minimum of one sample per 500m³ of material.

With reference to the conceptual site model and semi-quantitative risk assessment within Section 4, it is considered the combined screening and treatment of source materials reduces the risk to controlled waters through lateral migration of contaminants at the base of the embankment.

Robust site records, including site plans, will be kept to track materials testing and movements including the temporary stockpiling of fill within the lagoon area.

8.2.2 Imported general fill

Imported general fill to be used as embankment construction materials will be obtained from reputable, certified sources and accompanied by suitable test certificates. Recycled fill materials will ideally be WRAP (Waste Resource Action Programme) compliant or similar. Imported general fill will be tested on a frequency of 1 sample per 500m³ or a minimum of three tests per source and will be required to meet the maximum permissible concentrations for imported general fill soils within Appendix G. The criteria within Appendix G have been derived from CGL generic assessment criteria, except for phytotoxic metals; copper, nickel and zinc. For these contaminants, site specific criteria protective of controlled waters have been derived using the same approach adopted for the re-use criteria. The DQRA input parameters and model outputs for the phytotoxic metals are presented in Appendices D and E respectively.

8.2.3 Topsoil

Imported landscaping soils / topsoil will be obtained from certified, reputable sources and accompanied by suitable test data. A minimum of three tests per source and a frequency of one sample per 150m³ of imported landscaping soils / topsoil will be required. The test suite and resultant data will be required to meet the maximum permissible concentrations for imported capping soils, presented in Appendix H.

8.3 Drainage attenuation storage

The highway drainage from the embankments located west of the Grand Union Canal and the access roads around Pump Lane is proposed to be through an oil interceptor, attenuation storage and a flow control device. Current proposals for the attenuation storage is for it to be lined with impermeable membrane (Firestone Pondguard EPDM or equivalent), with a 300g/m² geotextile underlay. A concern regarding the potential mobilisation of contaminants due to infiltration of water through a ruptured liner and into the underlying soils, was raised during consultation with statutory authorities.

A plan location and cross section detail of the attenuation storage liner detail proposed by Create Consulting Engineers is shown in drawings A720-E05-IW-CCE-EW-DR-SK-0301 and A720-E05-IW-CCE-C-SK-0003 (Appendix I).

8.3.1 Ground conditions

The ground conditions in the immediate area of the attenuation storage are represented by trial pits (TP01C, TP02C & TP-5B) undertaken during the CGL investigation summarised within Sections 3.1.2 and 3.1.3 and trial pits (TP14, TP17 and TP36) undertaken during an earlier phase of investigation. The ground conditions generally comprise Made Ground between 0.50m to 0.90m thick, overlying Alluvium and a discontinuous layer of River Terrace Deposits. London Clay is encountered at depths of between 1.10m to 1.80m below ground level.

The Made Ground is shown to be a sandy gravelly clay. The Alluvium is shown to be a slightly sandy slightly gravelly clay. The River Terrace Deposits, where encountered, are shown to be a slightly silty sandy gravel. The intrusive investigation at this location has indicated that the granular River Terrace Deposits are not encountered as a continuous layer. This has also been observed at other areas of the site, in relation to the temporary lagoon stockpile, as discussed in Section 7.2.

The risk of contaminant leaching as a result of damage to the liner is considered to be **low** based upon the conceptual model presented in Figure 6. The proposed depth of the storage basin results in the base being founded within the London Clay, which limits migration of groundwater in the vertical direction. Lateral migration of groundwater is likely to be limited by the low permeability Alluvium. There is potential for discontinuous lenses of high permeability River Terrace Deposits to provide a pathway towards the Yeading Brook. Due to limited contamination testing within the immediate location, it is

not possible to identify the likely leachate concentrations that may pose a risk, therefore it is necessary to consider that contamination may be present within the Made Ground.

8.4 Materials Management Plan (MMP)

The MMP completed at PCSA stage has been updated to account for the material types and volumes defined as part of the detailed design phase. The finalised MMP¹⁷ has been subject to review by an independent Qualified Person, as required by the CL:AIRE Definition of Waste: Development Industry Code of Practice and the on-line declaration made on 28 July 2017. The MMP will be updated during the construction programme to account for variations in material volumes and type, with final details of material management to be captured within the scheme verification report.

8.5 Flood compensation area

The scheme includes for a new flood compensation area to provide sufficient flood alleviation for the Yeading Brook and diverted River Crane. At present, discussions are ongoing with the Environment Agency as to whether the flood compensation area requires a liner to be constructed. If a liner is required then the preferred option would be to construct it with site won Class 2A1 cohesive fill, if sufficient suitable material is available on site. If there is insufficient suitable site won material available then the material for the liner may be sourced from off-site or alternatively FM Conway may make use of an impermeable membrane, subject to agreement from the employer and Environment Agency.

Class 2A1 material is a derivation of Class 2A material, where certain selection criteria including material permeability is refined to keep such material within a define set of parameters for its end use. The specification for Class 2A1 fill is presented within the CGL Earthworks Specification (ref: A720-E05-IW-BR-CGL-EW-SPC-0001).

8.6 Piling risk assessment

A piling risk assessment for the permanent bridge abutment and retaining wall works was completed as part of the PCSA design phase, which has subsequently been updated and incorporated in the Geotechnical Design Report⁴ for the scheme. A copy of the risk assessment is attached as Appendix J. The assessment considered various potential pollution scenarios, in accordance with Environment Agency guidance¹⁸, and concluded

¹⁷ CGL, 2017, *Southall Western Access Materials Management Plan_rev2_CGN03732G_27 July 2017*

¹⁸ Environment Agency, 2001, *'Piling and penetrative Ground Improvement Methods on Land Affected by Contamination; Guidance on Pollution Prevention.'* NC/99/73 (2001).

that the proposed continuous flight auger (CFA) piling technique posed an overall very low risk to environmental receptors, though noted that contaminated arisings would need to be managed appropriately. Pile arising management will be dependent on the findings of initial ground investigation and data assessment from the previous phases of intrusive works but for the majority of materials will comprise stockpiling of arisings within the lagoon stockpile area followed by subsequent testing for potential re-use / treatment or disposal. Where previous contamination has been identified in an area of piling, arisings will be stored temporarily on plastic sheeting and covered over, prior to testing for potential re-use / treatment or disposal. Where necessary, a temporary sump will be constructed within the basal sheeting to allow for collection and disposal of impacted perched- / ground water within the arisings. Arisings from piling to the east of the GUC will be managed at source, as described above, and not moved to the lagoon stockpile area to the west of the canal to minimise unnecessary transportation of contaminated soils on the public highway. Where unexpected contamination is identified, this will be addressed in accordance with the discovery strategy set out in Section 10 and the process flow charts within Appendix L.

Temporary sheet piling, which is proposed adjacent to the Grand Union Canal, was not assessed as part of the PCSA phase piling risk assessment as details were unknown at that stage. A review has been undertaken for this addendum, which shows that the temporary sheet pile works are similarly considered to present a low risk to both environmental and human receptors. This is on the basis that the sheets are approximately 5 – 6m in length, will terminate within weathered London Clay and will therefore not create additional vertical migration pathways to the underlying aquifer. As with the earlier stockpiling risk assessments, the granular Lynch Hill Gravel deposits are indicated to be discontinuous. Therefore, temporary sheet piles driven through this unit pose only a low risk to receptors, based on limited pathway potential for contaminants. Furthermore, the sheet piles will be a temporary installation, during which groundwater and surface water monitoring will be undertaken to assess potential impact to key receptors and provide an early warning in the event of an increase in contaminant concentrations. In addition, as limited quantities of spoil will be generated during installation of the sheet piles they are also not considered to present a significant risk to human health in terms of potential exposure.

9. MONITORING STRATEGY

9.1 Introduction

A monitoring programme was identified as being required within the PCSA design phase in order to assess the potential risk to controlled waters during the material management element of the works.

This section presents the proposed groundwater and surface water monitoring programme and a contingency plan to be implemented in the event that groundwater/surface water monitoring indicates an unacceptable increase in contaminant concentrations.

9.2 Groundwater and surface water monitoring

In consideration of the proximity of the Yeading Brook to the site, groundwater and surface water monitoring is required to be undertaken to assess the potential risk to controlled waters, prior to, during and post all earthworks activities.

It is recommended that the monitoring network includes at least one up-gradient borehole to determine changes in background water quality and one down-gradient to provide early warning of deterioration of groundwater quality. It is also recommended that surface water samples are collected from the Yeading Brook from at least one point upstream and one point downstream.

The monitoring borehole installations are presented in Figure 3.

The proposed monitoring programme is presented in Table 6 below.

Table 6 - Monitoring Programme

Monitoring Location	Parameters to be Measured	Frequency of Monitoring Required ¹
One up-gradient (BH4B) and up to three down-gradient groundwater monitoring boreholes (BH1B, BH2B and BH3B) plus three lagoon source area boreholes (BH1A, BH2A and BH3A). Locations to be monitored by CGL.	Hardness; ammoniacal nitrogen; chloride, potassium, calcium and magnesium; Heavy metals including; arsenic, barium, beryllium, boron, cadmium, chromium, copper, lead, mercury, nickel, selenium, vanadium and zinc; Benzene, toluene, ethylbenzene, xylenes (BTEX) compounds; TPHCWG and PAHs; total monohydric phenols; total cyanide; free cyanide; sulfate; and pH determination. CGL surface water sampling to comprise ammoniacal nitrogen and un-ionised ammonia in addition to general suite by Ramboll Environ.	Two initial monitoring rounds prior to commencement of works, monthly during construction works, increased to weekly during key earthworks activities. Monthly post construction works up to three months and bi-monthly thereafter if no contamination is detected in the trigger locations up to one year following completion of the works. Water samples should be tested on a rapid laboratory turnaround where possible to ensure a prompt response.
One upstream, one mid-stream and one downstream surface water point. Surface water monitoring to be completed by FM Conway, Ramboll Environ and CGL.	In-situ parameters to be tested include: dissolved oxygen, redox potential, pH, temperature, electrical conductivity and total dissolved solids.	One initial monitoring round prior to commencement of works, weekly during earthworks activities and monthly post ground improvement works up to three months. Monitoring / sampling of ammonia to be undertaken concurrently with construction groundwater monitoring. Daily visual inspections of water quality including in-situ monitoring for the parameters noted.

Notes

1. The groundwater monitoring should be undertaken by a qualified geo-environmental engineer.

Following completion of the two baseline pre-construction groundwater monitoring rounds, undertaken by CGL in June and July 2017 (Appendix B), and three rounds of baseline monitoring by Ramboll Environ, the resultant data were reviewed to enable development of construction groundwater monitoring trigger levels. The groundwater trigger levels were derived for adoption during construction to act as indicators of deterioration in groundwater quality, which may be as a result of the influence of the scheme construction activities. The trigger levels presented (refer to Appendix K) are based on either laboratory limits of detection, where baseline monitoring data were less than these limits or have been set at 20% greater than the maximum concentration for those contaminants recorded above laboratory detection limits. Trigger levels are

presented for the individual boreholes to be monitored with the exception of the down-gradient boreholes BH1B and BH2B, both of which were dry during baseline monitoring. For these boreholes individual trigger levels have been provisionally determined, based upon the results obtained from baseline monitoring of borehole BH3B. These trigger values will be re-visited should boreholes BH1B and BH2B be found to contain groundwater during subsequent construction monitoring rounds.

For surface water monitoring, which is to be completed by FM Conway, Ramboll Environ and CGL, trigger levels have not been presented as it is not considered practicable to address breaches of a trigger concentration once that breach has already occurred within the receptor. It is proposed to track trends in surface water quality for the duration of construction and post construction, for the results to be reported and significant changes in water quality to be flagged to relevant parties.

Due to the concentrations of ammonia recorded in baseline groundwater monitoring it has been agreed with the Environment Agency that surface water sampling of Yeading Brook shall be undertaken, concurrently with the groundwater monitoring, to test for ammoniacal nitrogen and un-ionised ammonia concentrations. Baseline results are to be obtained for these parameters, within the brook, over three rounds and the data reviewed to establish suitable trigger levels, likely based on the approach outlined above.

9.3 Groundwater / surface water and mitigation contingency plan

The groundwater in the River Terrace Gravel aquifer will be monitored up and down gradient of the site during the earthworks activities and will be reviewed against the trigger levels presented herein. As noted above, monitoring is also to be undertaken for ammonia species within the Yeading Brook at the same time as the groundwater monitoring.

Where the groundwater or surface water monitoring data indicate unacceptable increases in contaminant concentrations above the agreed trigger levels then the following mitigation contingency plan will be implemented. This contingency plan is presented, within the context of the wider watching brief and discovery strategy (Section 10), as a process chart and is contained within Appendix L and outlined below:

1. Repeat sampling on an increased frequency (minimum weekly) to assess the data over three rounds and see if the trigger levels breach is sustained.

2. Where three rounds of sampling indicate a continuous breach of trigger levels, earthworks or other potentially causative activities are to cease on site.
3. Where three rounds of monitoring show continuous breach of trigger levels, notify the Client, Environment Agency and Contaminated Land Officer at London Borough of Hillingdon, as required.
4. The results from the groundwater monitoring will be used to determine the extent of groundwater impacts and to assess the feasibility of various mitigation options. The contingency plan will be triggered where there is a recorded breach of trigger levels over three successive monitoring rounds. It is noted that the implementation of the contingency measures will largely depend on the scope and extent of groundwater impacts. Therefore, a suitable solution is to be proposed to the Environment Agency for agreement before implementing specific contingency remediation works or recommencing development works.
5. Verification of the contingency measures will need to be undertaken by a qualified geo-environmental engineer.

9.3.1 Indicative contingency measures

It is not possible at this stage to identify the contingency measure that would be appropriate for a given exceedance of the trigger levels. Based on the assessments undertaken within this report, it is anticipated that construction activities are unlikely to increase contaminant concentrations or mobilise contaminants via preferential pathways within the groundwater. In the event this does occur, it is anticipated that a relatively simple contingency measure may be appropriate. Below is one such example, however, this would have to be reviewed once the scope and extent of groundwater impacts are known.

A permeable reactive barrier typically involves installation of a permeable trench across the width of a contaminant plume to intercept and treat shallow and/or perched contaminated groundwater. As groundwater passes through the reactive zone, the contaminants of concern are typically transformed into harmless by-products. The barrier would need to be keyed into the underlying London Clay Formation. Monitoring should be undertaken for a minimum of three months' post treatment. Samples should be taken fortnightly for the first month and monthly thereafter.

Notwithstanding the above, it is important for the contractor to implement good site drainage and surface water controls to mitigate run-off of surface water into the Yeading Brook.

10. WATCHING BRIEF AND DISCOVERY STRATEGY

A watching brief is to be maintained by FM Conway and their earthworks contractor during construction works. This will focus on the key excavation and materials handling works including the proposed material cut from the flood compensation area, stockpiling within the lagoon, stabilisation of fill within the lagoon (where undertaken) and placement and compaction within the embankment footprint. Areas of known contamination, based on observations from previous investigation and subsequent assessment, are presented on a Contamination Observation Plan (Figure 4). Material within these identified areas will not be excavated for re-use within the scheme without suitable further assessment and treatment, as necessary.

Where unexpected contamination such as material of an unusual colour or odour; in particular, suspected gasworks related material such as spent oxides (e.g. 'blue billy') or black/dark grey coal tars, is encountered during earthworks then the following discovery strategy is recommended. This strategy is presented, in the context of the watching brief and groundwater contingency plan (Section 9), as a process chart contained within Appendix L and outlined below:

1. Notify geoenvironmental engineer to attend site, assess the contamination and sample material for appropriate analysis.
2. Where gross contamination (e.g. free product, asbestos containing materials or gasworks related waste) is encountered, cease work in that area of the site, fence off the area and advise BWT and their Environmental Guardian (Ramboll Environ).
3. Geoenvironmental engineer will notify the Contaminated Land Officer at London Borough of Hillingdon or Ealing, as appropriate and / or the Environment Agency contacts and agree the appropriate mitigation, which is likely to comprise the following.
4. Geoenvironmental engineer to supervise the excavation of contaminated material, where required, which should be placed in a separate, bunded area within the lagoon stockpile and covered, where practicable, to prevent rainwater infiltration.
5. Where required, soil samples should be obtained by the geoenvironmental engineer from both the excavated material, and the soils in the sides and base of

the excavation to demonstrate that the full area of contamination has been excavated.

6. On receipt of chemical test results, the soils may be appropriately classified for recovery, treatment or disposal, where appropriate, and dealt with accordingly. Grossly contaminated material such as gasworks related waste will not be re-used within the scheme.
7. To facilitate waste disposal or potential re-use of materials excavated soils should be segregated and stockpiled depending on their soil classification.
8. Detailed records of the stockpile(s) size, source, location and fate should be kept and regularly updated to allow materials to be easily tracked from excavation until leaving the site or re-used, as appropriate.
9. Records of excavated areas and the results of chemical testing should be incorporated within the final verification report for the scheme.

11. VERIFICATION

To confirm that the measures and procedures detailed in this document have been implemented, a Verification Plan has been produced and is presented in Appendix M. The Verification Plan sets out the measures to be undertaken during construction to verify the works are being undertaken in accordance with this Remediation Strategy Addendum report and in order to support completion of a Verification Report for the scheme.

The Verification Plan has been compiled to be in accordance with London Borough of Hillingdon decision notice (ref: PDU/2310/06) planning condition 21, which states:

Following completion of each Part of site remediation, and prior to the commencement of any further development of this Part, a validation/verification report demonstrating completion of the works set out in the remediation scheme together with amendments and longer-term monitoring for the relevant Part shall be submitted to and approved in writing by the London Borough of Hillingdon as the local planning authority.

Each validation/verification report shall include:

- a) Detail of who carried out the work*
- b) Laboratory and in-situ test results to demonstrate that the site remediation criteria have been met*
- c) Monitoring of groundwater and gases during remediation and details of monitoring programme post completion of remedial works, where agreed*
- d) Summary data plots and tables relating to clean-up criteria*
- e) Plans showing treatment areas and details of any differences from the original remediation strategy*
- f) Waste management documentation*
- g) Confirmation that remediation objectives have been met, for example, by provision of a certification of completion*
- h) A long term monitoring and maintenance plan for longer term monitoring of pollutant linkages, maintenance and arrangement for contingency action and for*

the reporting of this to the London Borough of Hillingdon as the local planning authority.

Site inspections and compliance testing should be carried out during the works by a qualified geoenvironmental engineer for the various elements of the remediation works as follows:

- Inspect, sample and arrange laboratory analysis of site-won soils for re-use within the scheme;
- Inspect and sample blended and stabilised fill material prior to re-use within the embankment;
- Sample and test imported soils, where required, to confirm compliance with the re-use criteria, including review of source data prior to import of material to site;
- Construction monitoring of surface waters and groundwater, in line with the monitoring programme to assess trends in water quality and provide an early warning of issues with groundwater quality potentially associated with site activities;
- Site inspection records, photographs and testing where unexpected contamination is encountered.

Documentation will also be required to be provided by the Contractors including:

- Photographs of the earthworks undertaken;
- As built drawings;
- Duty of care records for the disposal of soils;
- Source data and pre-import laboratory data of imported topsoil/subsoil;
- Material management procedures (i.e. permits, exemption, MMP etc.) as appropriate;
- Confirmation of piling methodology and depth of piles; and
- Records of soils treated / stabilised for re-use.