Thames Water Utilities Limited (Thames Tideway Tunnel) Order 2014

Application to Discharge Schedule 3 Requirements

PART 1 – Application details	
Application reference:	**C450-DRMST-PLN-WAN-003**
Local authority:	London Borough of Wandsworth
Requirement no:	Partial discharge, DRMST3 Contaminated Land River wall
Status of application (please delete as necessary):	Draft for comment
Date application submitted:	20 March 2015
Target date for application to be determined:	17 April 2015

Description and location of the Works			
Contract (e.g. West/East/ Central/other):	West	Site name/tunnel section:	Dormay Street
Brief description:	This draft submission is for partial discharge of the Requirement DRMST3 and is related to the replacement of the river wall, demolition of warehouse, gatehouse and existing substation. This application constitute partial discharge as it relates to the construction works associated with the river wall works only.		
Location:	Dormay Street, SW18 1ER		
Anticipated construction start date	Q2, 2015	Site area (ha):	0.224

Applicant details			
Organisation:	Thames Water Utilities Limited		
Name of applicant:	Phil Stride		
Signature:	Phil Stride		
Position:	Head of Thames Tideway Tunnel		
Address:	The Point, 37 North Wharf Road, Paddington, London W2 1AF	Tel:	02087925583
Enquiries to:	Jonathan Harris	Email:	jonathan.harris@tidewaytunnels.co.uk

Thames Tideway Tunnel

Creating a cleaner, healthier River Thames

PART 1 – Application details			
Applicant's Agent/Contractor			
Agent/Contractor:	Thames Tideway Tunnels		
Name:	Jonathan Harris		
Position:	West Planning Manager, Thames Tideway Tunnels		
Address:	The Point, 37 North Wharf Road, Paddington, London W2 1AF		
Signature:			
Tel:	02087925583	Email:	jonathan.harris@tidewaytunnels.co.uk
Site visit:	If the Consent Granting Body has enquiries or needs to carry out a site visit they should contact: Jonathan Harris, West Planning Manager, Thames Tideway Tunnel		

Pre-application advice	
Local authority:	London Borough of Wandsworth
Contact:	Roy Fox
Notes:	Early engagement with the Area Environmental Health Officer of LBW, to agree the scope of submission required to discharge Requirement DRMST3, Contaminated Land, which is triggered by the enabling works at Dormay Street worksite. By way of email dated 25 November 2014, LBW confirm the scope and approach of this submission. The email correspondence is provided as supporting information with this submission.
Previous application reference (if relevant):	n/a

PART 2 – Application documents and Plans for approval		
Submission reference:		
No.	**Document/Plan title**	**Document/Plan reference**
1	Phase one contamination risk assessment report	307-PX-ENG-RW570-000001
2	Site Plan	117-DA-PNC-DRMST-146202 Rev AA.1

Supporting documents for information only*			
No.	**Document title**	**Document reference**	**Provided (Y/N)**
1	Email Correspondence LBW to and from TTT	n/a	

* Reference any related documentation not formally forming part of this application, any relevant documents that may have been previously submitted (including references and dates); include details of any meetings and discussions (including dates).

Thames Tideway Tunnel

Creating a cleaner, healthier River Thames

Thames Water

Mr John Stone
Head of Forward Planning and Transportation
London Borough of Wandsworth
The Town Hall
Wandsworth High Street
London
SW18 2PU

Ref: C450-DRMST-PLN-WAN-003

20 March 2015

Dear Mr Stone,

The Thames Water Utilities Limited (Thames Tideway Tunnel) Order 2014 as amended by The Thames Water Utilities Limited (Thames Tideway Tunnel) (Correction) Order 2015, Application to discharge Schedule 3 Requirement – DRMST3
London Borough of Wandsworth – DRMST3 Contaminated Land – C450-DRMST-PLN-WAN-003
Dormay Street worksite, works to the river wall

We submit together with the original, two copies and one electronic copy on a DVD of our draft submission relating to a request for the approval of the partial discharge of Schedule3 Requirement DRMST3 (Contaminated Land) relating to the replacement river wall and associated demolition works at Dormay Street in the London Borough of Wandsworth, under Schedule 3 (1) of the Thames Water Utilities Limited (Thames Tideway Tunnel) Order 2014 (the Order) as amended by The Thames Water Utilities Limited (Thames Tideway Tunnel) (Correction) Order 2015 (the Order). This draft submission for the proposed application to discharge Requirement DRMST3 relates to the replacement of the river wall and demotion of warehouse, gatehouse and existing substation. Requirement DRMST3 states:

Site-specific remediation strategy

(1) No works shall be carried out at this site (except for demolition of existing buildings, works in the highway including site access, works to trees and installation of monitoring equipment), unless otherwise agreed, until the following are submitted to and approved by the relevant planning authority in consultation with the Environment Agency—

a) a preliminary risk assessment and site investigation scheme which identifies—

all previous uses

potential contaminants associated with those uses

a conceptual model of the site indicating sources, pathways and receptors

a qualitative risk assessment of any potentially unacceptable risks arising from contamination at the site

a proposed site investigation scheme providing information for a detailed quantitative assessment of the risk to all receptors that may be affected, including those off-site.

b) a remediation strategy which includes—

Thames Tideway Tunnel
The Point
37 North Wharf Road
Paddington, London
W2 1AF

Tel: **020 3147 7700**
Fax: **0203147 7701**
Web: **www.thamestidewaytunnel.co.uk**

Registered in England and Wales **No. 2366661**
Registered office: **Clearwater Court, Vastern Road**
Reading, Berkshire, RG1 8DB

the results of the site investigations

a detailed quantitative risk assessment

an options appraisal giving full details of the remediation measures required and how they shall be carried out

a verification plan providing details of the data to be collected in order to demonstrate that the works set out in the remediation strategy are complete and identifying any requirements for long-term monitoring of pollutant linkages, maintenance and arrangements for contingency action

a programme for the submission of elements detailed in (3) and (4) below.

(2) The authorised development shall be carried out in accordance with the approved details, unless otherwise agreed with the relevant planning authority in consultation with the Environment Agency.

Verification report

(3) Prior to completion of the works, a verification report demonstrating completion of the works set out in the approved remediation strategy and the effectiveness of the remediation shall be submitted to and approved by the relevant planning authority in consultation with the Environment Agency. The report shall include results of sampling and monitoring carried out in accordance with the approved details to demonstrate that the site remediation criteria were met. It shall also include a plan for long-term monitoring of pollutant linkages, maintenance and arrangements for contingency action as identified in the verification plan.

(4) The long-term monitoring and maintenance plan shall be implemented in accordance with the approved details, unless otherwise agreed with the relevant planning authority in consultation with the Environment Agency.

Unexpected contamination

(5) If, in carrying out any works on this site, contamination not previously identified is found to be present, then unless otherwise agreed by the relevant planning authority, no further development or works shall be carried out in the part of the site in which the contamination is identified until a remediation strategy is submitted to and approved by the relevant planning authority in consultation with the Environment Agency. The authorised development shall be carried out in accordance with the approved details, unless otherwise approved by the relevant planning authority.

This application follows pre application engagement with the Council to discuss and agree the scope and content of the submission required to address requirement DRMST3 for the early works at Dormay Street worksite prior to commencement of main works on site. LBW confirmed the approach and content of the submission and a copy of the email correspondence is included in the application as supporting information.

This draft submission for the proposed application to discharge Requirement DRMST3 comprises a draft application form and the following draft documents/ plans that will be for approval:

1. Site Specific Remediation Strategy – Doc. ref 307-PX-ENG-RW570-000001
2. Site Plan 117-DA-PNC-DRMST-146202 Rev AA.1
3. Email confirmation from LBW to TTT on the scope and content of this submission

We request that you provide written confirmation of the receipt of this draft application and look forward to receiving any comments you may make within 28 days.

Should you wish to discuss this matter further, please contact the Planning Manager for the west section of this project, Jonathan Harris on 0208 792 5583 or email jonathan.harris@tidewaytunnels.co.uk.

Yours sincerely

Phil Stride
Head of Thames Tideway Tunnel

Daria Halip

Subject: FW: Dormay Street Trial Holes Summary

From: Fox, Roy [mailto:RFox@[redacted]]
Sent: 25 November 2014 15:18
To: Barney Forrest
Cc: Hutchings, Adam
Subject: RE: Dormay Street Trial Holes Summary

Barney

As discussed during our telephone conversation on Friday 21st November, following my review of the information that you sent me, I have listed below a number of the points raised.

- I confirm my agreement that the sampling results show low to moderate range of contaminating substances commonly found on commercial/industrial urban sites. The results do not present a significant risk for unacceptable exposure given an ongoing commercial/industrial use.
- The seperate areas do not form a homgeneous site from the perspective of soil type and quality.
- There are no acute risks apparent that cannot be addressed by normal health & safety measures taken by site workers.
- The most significant risk arises to the Bell Lane Creek during the river wall repair works. However, the proposed methodology that you indicated on the telephone should be satisfactory to mitigate this risk. The Environment Agency will need to agree this.
- Consideration of human health risks under the contaminated land regime largely relates to the possibility for unacceptable exposure to residual contaminants arising from the final, developed, use of the site. This is a matter for the assessment of the main shaft & tunnelling works, rather than the early works, and the proposals for the finished surface design.

Based on the above points, the following paragraph sets out my conclusion in connection with the works we have discussed and the DCO.

With respect to the specific requirements for the Dormay Street site contained in the DCO, reference DRMST3 (1), I can confirm my opinion, subject to the agreement of the Environment Agency with respect to the protection of controlled waters,that for the early works, which comprise preparatory works to enable the scheme proper to be progressed, the investigations and assessment carried out to date are satisfactory to allow these works to be undertaken. For the main works the full requirements of DRMST3 (1) will need to be followed.

Regards,

Roy Fox
Area Environmental Health Officer
Wandsworth Borough Council
Public Health Division, Environmental Services
PO Box 47095
London, SW18 9AQ

Tel: 020 8871 7874

From: Barney Forrest [mailto:Barney.Forrest@tidewaytunnels.co.uk]
Sent: 20 November 2014 17:26
To: Fox, Roy
Subject: Dormay Street Trial Holes Summary

Hi Roy,

In advance of our discussion tomorrow I thought the overview of the results from the recent trial holes might help inform our discussion.

Many thanks

Barney

Please find below a high level summary of the results of contamination testing carried out on samples taken from four trial hole locations at Dormay Street (TH12-TH15).

From the trial holes (TH12-TH15), 8 samples of made ground from depths between 0.3m and 1.75m were tested for the presence of contaminants. In addition the samples were also classified for waste purposes by the contractor.

Made ground samples taken at depths of 0.3m and 0.75m at TH14 were classified as inert waste. The made ground sample taken from TH12 (0.75m) was also classified as inert waste.

Made ground samples taken from TH13 were classified as follows:

0.3m – stable non-reactive hazardous waste
0.45m – non hazardous
0.5m - stable non-reactive hazardous waste
1.1m – hazardous waste

In addition, the sample of made ground from TH15, taken at a depth of 1.75m was classified as non-hazardous waste.

Soil contaminant concentrations were compared against Soil Guideline Values and Generic Assessment Criteria for light industrial/commercial land-use. Exceedances of the withdrawn SGV lead value were recorded in the sample taken from TH12 (0.75m) and TH13 (0.3m).

An exceedance of PAH, benzo(a)pyrene was detected within the made ground at TH13 , 0.5m.

TPH concentrations detected were, for the majority of the samples, recorded at concentrations below the screening criteria. This is with the exception of TH13 (1.1m) and TH15 (1.75m). The sample of made ground taken at TH13 (1.1) recorded a concentration of TPH aliphatic >C12-C16 in exceedance of the soluble screening criteria.

The made ground sample taken from TH15 (1.75m) detected concentrations of TPH aliphatic >C10-C12, TPH aliphatic >C12-C16 and TPH aromatic >C12-C16 above the soluble screening criteria.

BTEX, MTBE, total phenols and PCBS were not detected at concentrations above the method of detection limit. Other VOCs, SVOCs were not tested for.

Asbestos was not detected within those samples screened.

IMPORTANT:
Confidentiality: This email and its attachments are intended for the above named only and may be confidential. If they have come to you in error you must take no action based on them, nor must you copy or show them to anyone. Please reply to this email and highlight the error.

Please visit the Council's website at: www.wandsworth.gov.uk

THE THAMES WATER UTILITIES LIMITED (THAMES TIDEWAY TUNNEL) ORDER 2014 (S.I. 2014/2384)

NOTICE UNDER SCHEDULE 17 Paragraph 1 (1)

Take Notice that Thames Water Utilities Limited is intending to apply to the London Borough of Wandsworth to partially discharge Requirement DRMST3 of Schedule 3 of the above Order.

The application will be for construction of the river wall, as part of the Thames Tideway Tunnel project.

A copy of the draft application may be inspected at the offices of the Council at the address below. An appointment will need to be arranged by emailing thamestunnel@wandsworth.gov.uk or ringing 0208716650/6628. Electronic copies can be provided by the council on request.

Planning and Development Division
Housing and Community Development Division
2 Adelaide Road
London SW18 2PU

Any person who wishes to submit a representation in respect of the draft application should send written comments to the Council at the address below or by emailing thamestunnel@wandsworth.gov.uk , quoting the Thames Tideway Tunnel submission reference C450-DRMST-PLN-WAN-003, by 16 April 2015.

Planning and Environmental Services
Environment and Community Services Department
Wandsworth Borough Council
Wandsworth High Street
London SW18 2PU

Thames Water Utilities Limited

20 March 2015

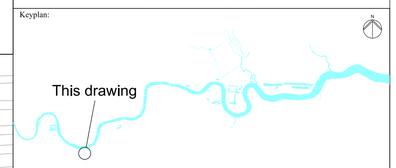
Goods Shed
Cable Bridge
Mud
Viaduct
MP 5
Mud
Mean High Water
River Wandle
THE CAUSEWAY
Delta Park
5
8
Works
Warehouse
Depot
25
Mud
Mud
MHW
Mean High Water
Mud
Bell Lane Creek
Mud
MLW
MLW
Mean High Water
Pipe Bridges
Sluice
Application site area = 0.2218ha
Chy
Hilden House
WB
El Sub Sta
THE CAUSEWAY
DORMAY STREET
Works
WANDSWORTH
FROGMORE
1 to 6
7
8 to 13
London Court
20
1 to 4
9 to 12
Car Park
Works
61
Works
Works
Pipe Bridge
El Sub Sta
Windsor Court
5 to 8
13 to 16
14 to 19
20 to 25
Westminster Ct
63
22
20
16
PH
ARMOURY WAY
Brewers House
1 to 8
Fullers House
Vine House
1 to 8
1 to 12
24
26
LB
Horse Exercise Area
Stables
1 to 6
Middlemill House
1 to 8
28
Brazil House
1 to 8
Bolting House
35
Works
DW
River Wandle

N

Do not scale - if in doubt ask

Status: FOR PLANNING

Keyplan:



This is a working draft plan which has been produced for the purpose of confidential discussions only. This plan must not be copied, distributed or shown to any third party without the express written permission of Thames Water Utilities Limited. The plan is subject to the outcome of the application for development consent for the Thames Tideway Tunnel.

Coordinates are to Ordnance Survey Datum OSGB36. All levels are in metres and relate to the tunnel datum which is 100 metres below Ordnance Datum Newlyn.

Key:

- Limits of land to be acquired or used (LLAU)
- Application site boundary

10m 0 40m

Scale 1 : 500

Revision History

Iss	Description	Dsgnr	Chkd	Appd	Date
AA	FIRST ISSUE	CMUR	CMUR	DARD	03/03/2015

Thames Tideway Tunnel
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Location Code:	OS Reference:	Security Reference:	Sub Process:	Drawn By:
N/A	TQ2574	UBR	WASTE	APUR

Location: WANDSWORTH - CS07AR - FROGMORE SR-BELL LANE CK

Site Name: DRMST - DORMAY STREET

Project Name: THAMES TIDEWAY TUNNEL

Contract Name: C450 - DORMAY STREET RIVER WALLS

Drawing Title: SITE PLAN FOR PARTIAL DISCHARGE OF SCH 3 REQUIREMENT DRMST3 (CONTAMINATED LAND)

Drawing No.:	Scale:	Sheet Size:	Rev:
117-DA-PNC-DRMST-146202	1:500	A1	AA

PLOTTED ON 20/03/2015 BY LOCATION : e:\async working dir\pw-ttp_pdf_svc_2\dms49783\117-DA-PNC-DRMST-146202.dgn

Site Specific Remediation Strategy Dormay Street Site River wall replacement and associated demolition

Contaminated land

Thames Tideway Tunnel

Site Specific Remediation Strategy Dormay Street Site Advanced Works

Name	Data
Document no:	307-PX-ENG-RW570-000001
Document type:	Report
WBS code:	
Owner:	
Author:	Mark Griffiths
Keywords:	Dormay Street, Remediation Strategy, Contamination

Contents amendment record

This document has been issued and amended as follows:

Revision	Date	Issued for/Revision details	Revised by
AA	05/12/14	Draft to client comment	MG
AB	17/12/14	Draft to client incorporating client comments	MG
AC	07/01/15	Draft submission to the London Borough of Wandsworth	TTT Project Team
AD	21/01/15	Minor revisions based on client comments	MG
AE	18/02/15	Updated with the results of the latest phase of foreshore ground investigation	BM
AF	03/03/15	Updated with comments from TTT	BM

Required approvals

Name	Role	Signature	Date
Suzanne Burgoyne	Environment Manager		
Ian Fletcher	Planning Manager		
Jeff Meerdink	Consent Delivery Manager		
Pablo Garzon	CAT 2/3 Delivery Manager		

Phil Stride	Head of Thames Tideway Tunnels		

Thames Tideway Tunnel

Site Specific Remediation Strategy Dormay Street Site – River wall replacement and associated demolition

List of contents

Page number

List of figures

List of tables

1 Introduction

1.1 Background

1.1.1 The Dormay Street site is located in the London Borough of Wandsworth (LBW) at the northern end of Dormay Street, adjacent to Bell Lane Creek.

1.1.2 The 'Dormay Street' construction site consists of two separate parcels of land to the north and to the south of Bell Lane Creek. The permanent works will be located on the south side of the creek.

1.1.3 The southern construction site area includes:

a. Lands owned by Thames Water immediately west of The Causeway (Private Road)

b. part of a London Borough of Wandsworth operations depot to the west and south of TW owned lands

c. a small area of the public highway at the northern end of Dormay Street.

1.1.4 The northern site (Causeway Island) is part of the LBW depot and is accessed by The Causeway (private road).

1.1.1 The site is shown in Figure 1.

1.1.2 The Thames Tideway Tunnel works at this site will be used to intercept the Frogmore Storm Relief combined sewer overflow CSO (Bell Lane Creek Branch). This will involve construction of a large diameter shaft as well as associated structures. A tunnel boring machine (TBM) will be launched from the shaft for the Frogmore Connection tunnel to the King George's Park and Carnwath Road Riverside sites. The remainder of the site will become a service yard during the construction of the shaft and the Frogmore connection tunnel.

1.1.3 In advance of the shaft construction works, a number of enabling works on the southern site will be undertaken. The area of this work is shown on Figure 2. These advanced works will include the construction of a new river wall and intertidal terrace, demolition of an existing river wall, removal of a weigh-station and demolition of onsite buildings including the warehouse, gatehouse and boundary wall as well as an electricity substation. A new substation will be constructed in the east of the site. The works to relocate the existing substation and provide a temporary power supply for the TBM are being addressed under a separate application and are not considered further in this report.

1.1.4 This document relates to the advanced works only and is specific to those small areas of the Dormay Street site where those works occur. Separate assessment will be prepared for the subsequent phases and the shaft construction works.

1.1.5 A Phase 1 Contamination Risk Assessment Report (see below) was previously prepared by Mott MacDonald which included desk study and preliminary risk assessment. In additional some previous phases of targeted investigation has been undertaken. This document summarises the findings of the previous assessments and presents an updated assessment and remediation strategy in a single report based on some recent site specific investigation for these works.

1.2 Site specific documentation

1.2.1 Documents related to the site and the proposed TTT works include:

a. Code of Construction Practice (CoCP) Part A and B:

i Identifies requirements and commitments made that should be applied to reduce and mitigate the effects of the project during construction.

1.2.2 The following site specific reports and data have been reviewed when preparing this assessment:

a. Mott MacDonald, November 2013, Thames Tideway Tunnels: Dormay Street, Wandsworth, Phase 1 Contamination Risk Assessment Report (321835/EVT/EES/01/D);

b. Mott MacDonald, August 2014, Thames Tideway Tunnels: Dormay Street, Wandsworth, Phase 2 Contamination Assessment (321835FF02/EVT/EES/DRM01/A);

c. Thames Water, September 2013, Geotechnical Desk Study: PWH7X – Dormay Street (100-RG-GEO-PWH7X-000003);

d. Thames Water, October 2013, Land Condition Report – Dormay Street (150-RG-ENV-PWH2X-000001);

e. Thames Water, July 2013, Thames Tideway Tunnel Ground Investigation Report PWH7X – Dormay Street (100-RG-GEO-PWH7X-000006_AC);

f. Fugro Engineering Services, December 2013, Thames Tideway Tunnel Dormay Street River Wall Investigation - Factual Report On Ground Investigation (302-RG-GEO-LC222-00004);

g. Structural Soils, May 2011, Interpretive Report on Ground Investigation at Dormay Street Wandsworth (Report 725401).

1.2.3 The site specific remediation strategy (SSRS) has been developed based on the reports described above and relates specifically to the advanced works site at the former Keltbray Yard. The report includes:

a. A summary of the preliminary risk assessment including details of any embedded mitigation and verification. This includes details of the rationale for the recent ground investigation based on a previous review of the Phase 1 study and previous ground investigations;

b. A generic quantitative risk assessment (GQRA) using generic assessment criteria (GAC) and following guidance in Model Procedures for the Management of Land Contamination, referred to as CLR11 (EA, 2004)[1] to consider the level of risk associated with pollutant linkages and what form of mitigation is required, with verification; and

c. A remediation strategy that takes account of the residual plausible pollutant linkages, taking account of embedded mitigation and the specific nature of the proposed preparatory works including verification requirements.

1.3 Proposed development

1.3.1 In summary the advanced works will include:

a. Replacement of a section of the river wall by:

i Installation of a new hard/firm secant piled retaining wall behind the line of the existing river wall (see Figure 3);

ii Remove residual soil material (up to 3m deep) between the new wall and the old and formation of an ecological terrace; and

iii Removal of the existing retaining wall in front of the new wall and installation of scour protection in front of the new wall.

b. Removal of a weigh-bridge and replacement with temporary hard standing; and

c. Above ground demolition of existing site buildings including the warehouse, the gatehouse to the depot, a boundary wall adjacent to the gatehouse and the existing substation. The demolition is proposed to down to ground slab level and will not involve any below slab penetration and the ground will not be disturbed.

1.3.2 Further detail of the proposed works is presented in Section 3.

1.3.3 Relocation of the electricity substation equipment to a new permanent substation in the south-east of the site is planned however this does not form part of the works being assessed in this report.

1.3.4 Upon comepltion of all Thames Tideway works at Dormay Street the site will be used as a service yard for the construction of the large diameter shaft (Dormay Street shaft). In the interim period the site will be unused and be finished with a temporary hard standing. Occasional access to the site may be required for maintenance of the new electrical substation or visits from contractors/ consultants appointed for the TTT scheme.

[1] Environment Agency (2004) Model Procedures for the Management of Land Contamination, Contaminated Land Report, 11.

1.4 Objectives and scope

1.4.1 A Development Consent Order (DCO) has been granted for the site. The DCO includes a number of requirements in Schedule 3 including those related to contaminated land which are in accordance with UK good practice and including a phased assessment of ground contamination, from desk study, through ground investigation, remediation and then verification, based on a continually updated conceptual model for the proposed works. These works trigger a number of Schedule 3 requirements including DRMST3 – Contaminated land. This Site Specific Remediation Strategy (SSRS) is intended to support a partial discharge of DRMST3 (1) for the works described above. It will subsequently be followed with a verification report prior to completion of these works. A site wide assessment will be submitted for approval at a later date.

1.4.2 This remediation strategy outlines the mitigation measures which are required (over and above embedded mitigation) to reduce the risks to human health and environmental receptors based on the updated conceptual model and residual plausible pollutant linkages.

1.5 Remediation strategy tiered approach

1.5.1 This remediation strategy builds on the information and assessments presented the Mott MacDonald Phase 1[2] and Phase 2[3] Contamination Risk Assessment Reports for the wider site. Reference is also made to the earlier Thames Water Geotechnical Desk Study[4], Land Condition Report[5], Ground Investigation Report[6] and Environmental Statement[7].

1.5.2 Intrusive investigation of the specific areas associated with the works was undertaken in October 2014 and January 2015 in order to supplement earlier investigation work. This most recent investigation is described in Section 4.2.

1.6 Liaison with stakeholders

1.6.1 Consultation has been undertaken with the Contaminated Land Officer (CLO) at LB Wandsworth. The purpose of this report, which will be submitted for approval in accordance with the DCO requirements, and is described in Section 1.4, was explained to the CLO. It was agreed that based on the limited extent and depth of the advance works that a single

[2] Mott MacDonald, November 2013, Thames Tideway Tunnels: Dormay Street, Wandsworth, Phase 1 Contamination Risk Assessment Report (321835/EVT/EES/01/D)

[3]Mott MacDonald, August 2014, Thames Tideway Tunnels: Dormay Street, Wandsworth, Phase 2 Contamination Assessment (321835FF02/EVT/EES/DRM01/A)

[4] Thames Water, September 2013, Geotechnical Desk Study: PWH7X – Dormay Street (100-RG-GEO-PWH7X-000003)

[5] Thames Water, October 2013, Land Condition Report – Dormay Street (150-RG-ENV-PWH2X-000001)

[6] Thames Water, July 2013, Thames Tideway Tunnel Ground Investigation Report PWH7X – Dormay Street (100-RG-GEO-PWH7X-000006_AC)

[7] Thames Water, Dormay Street Environmental Statement

SSRS report could be submitted that also summarised the key early steps (desk study and investigations) that have been completed previously.

1.7 Basis for remediation design

1.7.1 The remediation strategy and mitigation measures have been developed to be protective of human health and environmental receptors during the construction phase and during the period following the advanced works.

1.7.2 It is assumed that soil excavation will be limited to that described in the works and that will be required during piling, removal of the existing substation and weigh-station and removal of residual soil between the new and old river walls.

1.7.3 It is assumed that there is no current possibility to re-use excavated soils on site and all excavated material will be transported off site, possibly for treatment and beneficial reuse at an offsite recycling centre. It is assumed that material removed from site will be assessed and controlled under a Duty of Care system and waste management legislation.

1.7.4 This assessment does not consider the risks to construction workers or users of adjacent sites resulting from the demolition of the existing site buildings including the electrical substation above ground. That process will be appropriately managed by a specialist demolition contractor.

1.7.5 During construction site personnel will be required to follow site Health and Safety procedures, including specific procedures outlined in method statements for certain tasks and in accordance with the CoCP.

1.7.6 It is assumed that assessments for building materials such as buried concrete and services will be undertaken and specified separately.

1.7.7 Following the advanced works it is assumed that the site will be secured and access to the site will be controlled. It is assumed that access will be restricted to members of the TTT teams, such as contractors and consultants, and maintenance workers who will require occasional access to the new substation.

2 Background information

2.1 Introduction

2.1.1 This section provides a summary of the Dormay Street site and environmental setting, focussing on the Keltbray Yard area which is the location of the advanced works. Further detail is presented within the Mott MacDonald Phase 1 and Phase 2 Contamination Assessment Reports and Thames Water Geotechnical Desk Study.

2.2 Site location

2.2.1 Dormay Street is located approximately 300m south of the River Thames in the London Borough of Wandsworth and is centred at approximate grid reference 525530,175000. The site location is shown in Figure 1. The site is bounded by a railway line to the north, The Causeway and River Wandle to the east and the LB of Wandsworth vehicle/maintenance depot to the west. The current site layout is shown in Figure 2.

2.2.2 Land surrounding the Dormay Street site is of a similar commercial/ industrial nature with the exception of residential properties (apartments) to the west around Frogmore (road), and Wandsworth Gasworks situated east of the River Wandle.

2.2.3 Keltbray Yard, which is the location of the advanced works, is located in the southeast of the wider TTT Dormay Street site (see Figure 2). The proposed shaft will be constructed in the southwest of the Dormay Street site.

2.3 Site description

2.3.1 Causeway Island is in the north of the site, to the north of Bell Lane Creek. This land forms part of the LB Wandsworth Depot and is partially covered in tarmac. Tarmac is absent towards the south where soils and vegetation are exposed.

2.3.2 The Frogmore Depot area is located in the south west and is part of the LB Wandsworth Depot. This part of the site is occupied by buildings and hard standing. A fuel pump island is located in the centre of Frogmore Depot and an above ground storage tank (AST) is located the southeast of this fuelling station.

2.3.3 A site walkover survey, of the construction works site, was undertaken by Environmental Consultants from Ove Arup and Partners (Arup) on 10th of March 2014. At that time the site was being used by the LB of Wandsworth as a bus depot and formed part of the larger Frogmore depot.

2.3.4 The site was broadly divided into two distinct areas; the main bus depot area, and the river wall section. The majority of the main depot area comprised concrete hard standing which appeared to be in good condition.

In addition, this area also contained a disused weighbridge and a number of drainage grids.

2.3.5 The river wall section of the site sat behind a palisade fence (approximately 2m in height) set back approximately 2m from the river wall. Within this strip of land the concrete hard standing was in poor condition with a number of large cracks evident; in some sections vegetation was growing through the cracks in the hard standing. In addition, an electrical substation (which is planned to be relocated) is situated centrally in this area.

2.4 Summary of site history

2.4.1 The Thames Water Geotechnical Desk Study[4] and the Mott MacDonald Phase 1 report provide detailed descriptions of the site history within the Dormay Street site and surrounding area. A summary of the onsite history is presented in Table 2-1.

Table 2-1 Summary on-site historical mapping

Date (year)	Land use
1864 to 1895	Four buildings are shown to the south of Bell Lane Creek. Two circular features described as Maltkilns are shown immediately south of the northern two of these buildings and suggest the buildings are a malt house. Land to the north of Bell Creek is shown as open land with no buildings. The Causeway is shown running north-south within the site.
1896 to 1898	Wandsworth Royal Laundry is now shown in the location of the suspected malt house and has been slightly expanded in the east.
1909 to 1920/ 1910 to 1921	No significant changes are shown on the historical maps.
1947 to 1972	Royal Wandsworth laundry is no longer present and a ruin is shown in the location of the Maltkilns. New buildings are shown south of the ruin including a chimney. Walls are now shown within the site along Bell Lane Creek channel. An electricity works is shown north of Bell Lane Creek.
1972 to 1975	No significant changes are shown on the historical maps.
1976 to 1996	No significant changes are shown on the historical maps.

2.4.2 A summary of the offsite history is presented and Table 2-2.

Table 2-2 Summary off-site historical mapping

Date (year)	Land use
1864 to 1895	A number of suspected industrial or commercial buildings are present immediately south of Keltbray Yard. A canal and Wandsworth and Putney Gas Works are located 21m and 173m from the eastern site boundary respectively. Middle Mill and Wandsworth Home is to the south (40m from the southern boundary).
1896 to 1898	Board of Works Yard and Dye Works are shown immediately west of the site. A Railway Wharf and Timber Yard is shown 80m and 125m east of the eastern site boundary respectively.
1909 to 1920/ 1910 to 1921	Demolition of some of the suspected industrial/ commercial buildings between Bell Lane and the southwest boundary of the site. Slight expansion of the industrial or commercial buildings immediately south of Keltbray Yard (west of Bell Lane). Laundries are shown 40m south and 190m east of the site. The Timber Yard is no longer shown.
1947 to 1972	Armoury Way is now located immediately south of the site. The canal is no longer shown suggesting it has been in filled. Several tanks, gas works and tar works are shown immediately east of the site separated by the River Wandle.

Date (year)	Land use
1972 to 1975	A gasholder and works area are shown immediately east of the site.
1976 to 1999	No significant changes are shown on the historical maps.

2.5 Potential contaminants of concern

2.5.1 The Thames Water Geotechnical Desk Study[4] presents a summary figure showing the potentially contaminative land use within the Dormay Street site and surrounding area. This figure is reproduced in Appendix A. Only the rows that are referenced "6" in the first column are relevant to the area of the advance works considered in this report for on-site contaminants of concern.

Table 2-3 Summary of Contaminants of Concern (by land use)

Ref	Land use (year)	Potential contaminants of concern
1	Corporation Works/Yard (c1898-c1980)	Potential contaminants: Heavy metals, arsenic, boron, nitrates, sulphates, sulphides, asbestos, aromatic hydrocarbons, poly aromatic hydrocarbons (PAH), polychlorinated biphenyls (PCB), chlorinated aliphatic hydrocarbons
2	Bell Lane Creek (c1869-c1964)	Various depending upon source of infill but could include organic materials which will degrade to produce landfill gases (e.g. methane and carbon dioxide). Potential for others including asbestos.
3	Depot (c1988-present)	Heavy metals, asbestos, total petroleum hydrocarbon (TPH), aromatic hydrocarbons, chlorinated aliphatic hydrocarbons.
6	Royal Wandsworth Laundry (c1896-c1916)	Heavy metals, arsenic, selenium, free cyanide, nitrates, sulphates, asbestos, aromatic hydrocarbons, chlorinated aliphatic hydrocarbons, PCB's.
6, 28,33, 34,35	Various Works (c1968-present)	Heavy metals, arsenic, boron, nitrates, sulphates, sulphides, asbestos, aromatic hydrocarbons, PAH, PCB, chlorinated aliphatic hydrocarbons.
18	Wandsworth Tar Works and associated tanks (c1951-c1964)	Phenolics, PAH, ammoniacal liquors, cyanides, tar.
26	Gasworks and holder	Volatile aromatics, phenolics (phenol & creosol), PAH in coal tar and ash, hydrocarbons, heavy metals, free cyanide, ammoniacal liquors, sulphate and asbestos.

2.5.2 An electricity substation is currently located in the north of the Keltbray Yard area. There is a potential for leaks and spills (transformer oils) although typically these are located in controlled conditions, and may be bunded or on concrete floors. Historically transformer oils contained Polychlorinated biphenyl's (PCB) although these were phased out in the 1970s.

2.5.3 The historic laundry is noted as being present from c1896 to c1916 and as such the use of chlorinated compounds suggested in the previous studies (such as TCE) would not have been likely. In addition, PCBs did not find common use in industry until later; they were discovered at the end of the 19th century but large scale commercial use occurred much later. However various other works on site at later periods may have included PCB containing equipment. It would also be unusual for free cyanide to be associated with a laundry.

2.5.4 Potential key contaminants based on onsite uses include: various metals, cyanide, sulphates, sulphides, asbestos, polycyclic aromatic hydrocarbons (PAH), various petroleum hydrocarbons (TPH) including diesel, lubricating oils, heavy oils and polychlorinated biphenyls (PCB), and various solvents.

2.6 Regional geology

2.6.1 Mott MacDonald present a review of the regional geology within their Phase 1 and 2 Contamination Assessment reports[2,3]. The regional geology is also discussed in the Thames Water Geotechnical Desk Study[4]. A summary is presented below.

2.6.2 The British Geological Survey (BGS) 1:50,000 mapping shows the site underlain by superficial deposits of Alluvium overlying the Kempton Park Gravel Formation. The latter is a River Terrace Deposit (RTD) and both sediments are associated with the River Waddle and Bell Lane Creek. The BGS online mapping[8] shows artificial ground (Made Ground) in the area of the site, as would be expected based on the historical land use.

2.6.3 The site bedrock is formed of the London Clay Formation which is situated above the Harwich Formation, Lambeth Group, Thanet Sand Formation and White Chalk Subgroup.

2.6.4 The site ground conditions and geological profile based on the site specific and local information is presented in Table 4-1.

2.7 Regional hydrogeology

Summary

2.7.1 Two distinct aquifers exist at Dormay Street, the upper aquifer (Alluvium and RTD) and lower aquifer (Upnor Formation, Thanet Sands and the Chalk). The units forming the lower aquifer are considered to be in hydraulic continuity and therefore represent one aquifer. The upper and lower aquifers are separated by the low permeability London Clay Formation which is known to be an effective aquitard.

Aquifer classification

2.7.2 The EA classify the upper aquifer (alluvium and RTD) as Undifferentiated and Secondary A aquifers respectively. The London Clay is classified as an unproductive strata by the EA due to it's impermeable nature. The London Clay at the site provides a hydraulic barrier to any potential migration of contamination in the Made Ground to the underlying Lambeth Group, Thanet Sands and Upper Chalk. The Lambeth Group and Thanet Sands are classified by the EA as SecondaryA aquifers and the lower (Chalk) aquifer as a Principal aquifer.

2.7.3 Principal aquifers can support water abstraction and support river base flow on a strategic scale and are consequently more sensitive than

[8] BGS Geoindex: http://mapapps2.bgs.ac.uk/geoindex/home.html

Secondary A aquifers. The lower aquifers are in hydrologic continuity and often referred to collectively as the Chalk-Basal sands aquifer.

Groundwater levels and flow

2.7.4 The EA monitors groundwater levels within the lower aquifer in the Central London Basin. The Thames Water Geotechnical Desk Study includes an extract of the groundwater elevation contours around Dormay Street[4] and this is reproduced in Appendix B.

2.7.5 The groundwater contours show the groundwater elevation beneath Dormay Street is -28mOD (in January 2012) and groundwater flow is to the northeast. This conforms to the assumption that flow is towards the central London Basin from the areas of recharge in the northwest and southwest[9].

2.7.6 The most recent EA status report (2014)[9] has been reviewed and shows a change in groundwater level of about 4m around the Dormay Street site since 2013 and the latest level for January 2014 is approximately -20mOD.

2.7.7 It is assumed that the upper aquifer is in hydraulic continuity with the River Thames, River Wandle and Bell Lane Creek, although this may not be the case where the river wall cuts off the site.

Source Protection Zones

2.7.8 The site does not lie within any Source Protection Zone (SPZ). The nearest groundwater abstractions with associated SPZ are located more than 3.5km to the south.

Groundwater abstractions

2.7.9 There are several groundwater abstractions within a 2km radius of the site.

2.7.10 The largest recorded license is held by Rialto Homes PLC for groundwater remediation works which is licensed to abstract 182,500m^3/annum[4].

2.7.11 There is one Ground Source Heat Pump (GSHP) scheme licensed from the chalk 300m northeast of the site and a further licensed abstraction held 600m northwest from the site[4].

2.7.12 There are no known unlicensed upper aquifer groundwater abstractions within 1km of the Dormay Street site[5].

Hydrology

2.7.13 The River Wandle is located adjacent to and runs approximately parallel to the eastern site boundary. The River Wandle feeds Bell Lane Creek which flows through the wider Dormay Street site from the east to the north. Both of these surface water features discharge into the tidal River Thames which is located approximately 300m north of the site.

[9] EA, 2014, Management of the London Basin Chalk Aquifer: Status Report 2014

2.7.14 The River Thames and its tidal tributaries are considered to be high value water bodies. The WFD status for the Thames and its tributaries is presented in Table 2-4.

Table 2-4 Summary of hydrological features

Waterbody name / ID	Hydromorphological status	Current quality	Target quality (2027)	Distance from scheme (m)
Wandle (Croydon to Wandsworth) and the R. Gravney (GB106039023460)	Heavily modified	Poor/ Good	Good	0
Thames Upper (GB530603911403)	Heavily modified	Moderate	Good	300

Surface water abstractions

2.7.15 There are no licensed surface water abstractions within 1km of the Dormay Street site[3].

2.8 Flood risk

2.8.1 A flood risk assessment has been completed and is presented in the Environmental Statement for the Dormay Street site[7]. The flood risk assessment concludes that the site is located within Flood Zone 3a associated with the tidal Thames. Hydraulic modelling has shown that it lies outside of Flood Zone 3a associated with the fluvial River Wandle.

2.8.2 The assessment presented in this report includes surface water as a potential 'receptor' both during river wall and foreshore works.

2.9 Discharge consents

2.9.1 There are no discharge consents on the Dormay Street site. Eight consents are recorded within 250m of the site[2]. The closest of these is located approximately 22m to the west (downstream) of the site and relates to a temporary consent for storm sewerage overflow into Bell Lane Creek, issued to Thames Water Utilities Ltd[2].

2.10 Areas of ecological importance

2.10.1 There are no known areas of national ecological importance on or close to the site. The River Thames and its tidal tributaries are designated as Site of Importance for Nature Conservation (SINC) of metropolitan importance.

3 Proposed works

3.1 Summary of proposed works

3.1.1 It is proposed to prepare the Dormay Street site in advance of the main TTT construction works.

3.1.2 These advanced works include the following elements which are described in further detail below:

a. Installation of a new river retaining wall;

b. Removal of the existing river retaining wall and construction of an ecological terrace;

c. Removal of a weigh-station and temporary reinstatement; and

d. Demolition of existing site buildings to slab level.

New river retaining wall

3.1.3 A new river retaining wall is required at the south of Bell Lane Creek. The position of the new wall is shown in Figure 3 and the construction drawings/ details is shown in Appendix C. This retaining wall will be constructed to a depth of approximately -15mOD, which is within the London Clay Formation (see Section 4.4) and will not penetrate cohesive layers to the underlying lower aquifer.

3.1.4 The wall will be a Hard-Firm secant pile wall constructed of hard male piles which will overlap previously installed smaller firm female piles.

3.1.5 The female piles will be installed to a depth of approximately -4mOD and will be keyed into the London Clay Formation. The male piles will then be advanced partially through the female piles to form a continuous piled wall to approximately -4mOD. The male piles will be drilled to the full depth (-15mOD) within the London Clay Formation, and will be steel reinforced.

3.1.6 It is proposed to construct the piled wall using conventional rotary drilling or continuous flight auger (CFA) techniques. Both techniques are similar in that material will be brought to the surface and will require removal offsite. Appropriate health and safety measures will be required to protect construction workers from contaminants in the ground and groundwater. The upper aquifer will be cased off during piling.

Removal of existing river wall

3.1.7 Once the new river wall has been installed the existing river wall and residual material will be removed to allow construction of an ecological terrace (see Appendix C and Figure 5).

3.1.8 The first stage will involve excavation of the soil material situated between the new and old river wall. Excavation to approximately 3m depth is required and is expected to comprise a mixture of Made Ground and

Alluvium. This material will require removal off site for disposal or processing.

3.1.9 The original river wall will be demolished to a depth of approximately 1.65mOD once the residual soil has been excavated. The land between the existing wall and the new wall will become an ecological terrace. This will be constructed by installing layers of concrete blinding and reinforced concrete which will form the base of the terrace. This concrete will form a barrier against river current and wave action and any residual soil below the concrete layer (for instance including any residual contamination).

3.1.10 The Contractor has not yet completed the design of the foreshore scour protection works. However it is anticipated that these works will comprise a shallow excavation, not exceeding 50m^3 of material, to a maximum depth of 0.5m. The excavation will be infilled with a geotextile filter membrane and imported rock armour stone, of sufficient size to resist the hydrodynamic forces from water discharge over the adjacent weir.

Removal of weigh-station

3.1.11 A now disused vehicle weigh-station is located south of the new river wall (see Figure 3). It is proposed to remove the weigh-station and replace the excavated area with temporary hard standing.

3.1.12 The removal of this structure will include some breaking out of the material, which is predominantly concrete and some mechanical and electrical equipment, which will be removed from site. A limited volume of broken hard standing and some Made Ground soil may require excavation to provide space for a suitable sub base material for the new temporary hard standing.

3.1.13 It is possible that the concrete from the weigh-station may be crushed and processed and possibly recycled and used as sub base for the new temporary hard standing.

Demolition of existing buildings

3.1.14 It is proposed to demolish a warehouse in the west of the site and an electrical substation in the north of the site which is in the location of the proposed new wall. These features are shown in Figure 3. It is also proposed to demolish a gatehouse and boundary wall. There is no ground break associated with these demolition works.

4 Site specific information

4.1 Previous site investigation

4.1.1 This section describes the ground investigation within the Dormay Street site and focuses on investigation within the boundary of the advanced works in the south east. Several phases of ground investigation have been undertaken at the Dormay Street site and surrounding area including:

a. Thames Water (2009) (some distance off site);

b. Structural Soils (2011) (off site); and

c. Fugro Engineering (2013);

4.1.2 A summary of each of these investigations is presented below. A plan showing the position of the exploratory holes for each investigation phase is presented as Figure 5.

Thames Water (2009)[6]

4.1.3 Three boreholes (SA1105 (on-site), SA1106 and PR1107 (both to the west)) were drilled as part of the TTT project ground investigation for the Dormay Street site. The investigation was primarily for geotechnical purposes but included testing to provide preliminary information on levels of contamination. Groundwater sampling and ground gas monitoring was undertaken on site.

4.1.4 Eight soil samples comprising four samples of Made Ground, one sample of Alluvium, and three samples of London Clay were tested for metals and metalloids, PAH, TPH, volatile organic compounds (VOC), phenols, cyanide, ammoniacal nitrogen, pH and soil organic matter (SOM) content.

4.1.5 Soil testing identified concentrations of the contaminants that are typical of soils in an urban setting (e.g. some detectable PAHs and TPH). The testing did not however, record contaminants above GAC (reported by Mott MacDonald) for a light industrial (commercial) land-use[3].

Structural Soils (2011)[10]

4.1.6 Structural Soils Limited (SSL) undertook an investigation in 2011. The scope of works included the excavation of six cable percussive boreholes, two within the advanced works site boundary (BHSA4502 and BHSA4503).

4.1.7 Sixteen soil samples were analysed for the arsenic, cadmium, chromium (total), lead, mercury, selenium, boron (water soluble), copper, nickel, zinc, speciated PAH, TPH (TPH CWG including BTEX), speciated phenols, total cyanide, sulphide (acid soluble), sulphate (water soluble) and organic matter. Seven soil samples were screened for the presence of asbestos;

[10] Structural Soils, May 2011, Interpretive Report on Ground Investigation at Dormay Street Wandsworth (725401)

none of which detected any asbestos fibres. In addition, four soil samples were tested for waste acceptance criteria (WAC) suite.

4.1.8 No gross contamination was encountered in any soil samples from any of the boreholes. Chemical results indicated that, with the exception of one elevated lead result, all samples were well below the commercial screening thresholds . Although a strong organic odour was detected from two groundwater samples during monitoring rounds the PID readings and chemical analyses of the water samples did not indicate contamination.

Fugro Engineering Services (2013)[11]

4.1.9 Fugro Engineering Services (FES) sunk three cable percussive boreholes (SA6245, SA6242 and SR6241) to a depth of 9mbgl within the advanced works boundary. Disturbed samples were taken at each change in soil type and at regular intervals during the boring.

4.1.10 Chemical analysis included twelve soil samples and three groundwater samples being tested for a wide range of determinants which included: metals, cyanide, TPHCWG, MTBE, BTEX, PAH, speciated monohydric phenols, sulphide, sulphate, nitrate, soil organic matter (SOM), total organic carbon (TOC) and asbestos (screen). In addition, all of the soil and water samples collected were tested for a chlorinated solvent suite. The majority of these samples recorded concentrations below the low detection limit. One soil sample reported detectable but very low concentrations of trans-1,2-dichloroethylene (0.02mg/kg), tetrachloroethylene (0.79mg/kg) and trichloroethylene (0.06mg/kg). There are no specific published GAC for these compounds but the concentrations are either the same order of magnitude, or a order of magnitude below, the most conservative GAC for one of the most toxic chlorinated solvents (1,2-Dichloroethane (0.7mg/kg)). A further three leachability samples, taken for WAC purposes, were analysed for the same suite of contaminants.

4.1.11 Observations of groundwater levels in standpipes, from both boreholes, were made during a single return visit. Gas readings were made in the standpipes on a single occasion after the fieldwork period at the request of TTT.

4.2 October 2014 ground investigation

4.2.1 In October 2014 four trial pits were excavated within the advanced works area (TH12 to TH15). The trial pits varied in depth from 0.5m to 3m. Two (excavated as long trenches, one east west and one north south) were located adjacent to the proposed flood wall with multiple samples taken along the trench. One pit was located in the position of the new electrical substation. A further trial pit was located adjacent to a warehouse in the west of the advanced work site adjacent to the weigh-station (it couldn't be

[11] Fugro Engineering Services, December 2013, Thames Tideway Tunnel Dormay Street River Wall Investigation - Factual Report On Ground Investigation (302-RG-GEO-LC222-00004);

excavated directly on the weigh-station due to the existing obstruction). It had been planned to do investigation along the existing route of services to be relocated but that was not possible due to risk from the services. The positions are shown in Figure 5.

4.2.2 The trial pit in the location of the substation did not identify evidence of a former sump as shown in historical plans.

4.2.3 Samples of soil were collected for chemical testing by Site Analytical Services Ltd under supervision of Arup. Twelve samples of Made Ground were tested for metals, metalloids, pH, cyanide (total, complex and free), TPH CWG, MTBE, BTEX, PAH, phenol, and PCB, sulphide, sulphate, soil organic matter (SOM), total organic carbon (TOC) and asbestos (detailed screen to HSG248). Leachability testing was undertaken for all twelve samples which were assessed for waste acceptance criteria (WAC).

4.2.4 During the excavation of the trenches near the river wall there was visual evidence of hydrocarbons noted during excavation by the Arup consultant on site, although there is not description on the log. Observations of contamination from the site are discussed in Section 4.5.

4.2.5 Two samples of groundwater, collected from within trial pits, were tested for the contaminants above with the addition of electrical conductivity, ammoniacal nitrogen and biological and chemical oxygen demand (BOD and COD).

4.3 January 2015 ground investigation

4.3.1 In January 2015, six additional soil samples, from three locations (FS1, FS2 and FS3) were taken from the upper 1m of the shallow foreshore soil deposits. Samples of soil were collected for chemical testing and submitted to Chemtest Ltd for analysis. Six samples were subject to the same suite of analysis as the trench samples. Leachability testing was undertaken on all six samples. Although no visual evidence of contamination was encountered during the excavation of one of the pits (FS3) at ground a faint hydrocarbon odour is noted in the log.

4.3.2 Two surface water samples (SW1 and SW2) were taken from Bell Lane Creek as part of the sampling completed in the foreshore area in January 2015, a plan showing the location of where these samples were taken from is given in Figure 6. The surface water samples were tested for a range of contamiants which included volatile and semi-volatile organic compounds (VOC and SVOC).

4.3.3 Ground gas monitoring was not undertaken as part of this latest work and this is considered appropriate given the nature of the proposed works and the conceptual model for the development (i.e. river wall works etc).

4.3.4 The soil and groundwater laboratory data is presented in Appendix D. The results are assessed in section 7.

4.4 Site specific geology

4.4.1 This section is based upon the site specific information obtained during the investigations described above. The recent works were all shallow and previous investigations have been used to inform the deeper stratigraphy. A summary of the stratigraphy encountered at the site is presented in Table 4-1. Borehole records are presented in Appendix E.

Made Ground

4.4.2 Made Ground was encountered in all holes at depths ranging from 2.8 to 3.2m. The uppermost Made Ground was described as concrete (0.2m to 0.35m thick) over a sandy rubble underlay. Below this layer the material was described as clay, sand and gravel with occasional cobbles, and containing bricks, flint, concrete fragments, clinker and wood. Rare plastic was identified in one location (SA4502).

4.4.3 Within the foreshore area the shallow soils are described as a mixtue of greyish brown, silty gravelly sand and brown sandy silty clay with occasional inclusions of fragments of brick, flint, wood and concrete (this has not been included in the summary table (4-1) of site specific geological profile as information is only available for one metre).

Alluvium

4.4.4 A thin layer of alluvium was encountered in all holes (except SA4503). This layer ranged between 0.3m and 1.0m in thickness and was thicker towards Bell Lane Creek in the north. The material was generally described as very soft to soft grey to black sandy gravelly silt or silty gravelly peaty organic clay with rare shell fragments and occasional to frequent roots and rootlets.

4.4.5 An approximate 0.60m thick layer of spongy, plastic, black and dark brownish grey pseudofibrous peat was encountered at 3.43mbgl in borehole SA1105 which is located on land to the north of Bell Lane Creek.

Kempton Park Gravel (RTD)

4.4.6 This strata was described as predominately grey to brownish grey medium dense to dense sand and gravel with occasional cobbles.

London Clay Formation

4.4.7 The London Clay Formation was generally described as firm to very stiff fissured brown to brownish grey slightly sandy silty clay with rare mica and pyrite nodules, and occasional pockets or burrows in-filled with silt and selenite crystals. Bands of weak to very strong mudstone and siltstone were encountered in this formation.

Harwich Formation

4.4.8 The Swanscombe Member of the Harwich Formation was described as very stiff to hard brownish grey sandy slightly gravelly slightly glauconitic clay or silty sand and pockets of lignite. A cemented gravel bed is noted.

4.4.9 The Blackheath Member was encountered in boreholes PR1107 and SR1108. This unit is described as possibly weak to strong and very stiff to hard, greyish brown slightly sandy slightly gravelly clay with rare shell fragments, underlain by weak light brown and dark grey slightly sandy gravelly siltstone.

Lambeth Group

4.4.10 The Thames Water 2009 investigation6 encountered five formations belonging to the Lambeth Group The Lambeth Group: Upper Shelly Beds, Upper Mottled Beds, Laminated Beds, Lower Mottled Beds and the Upnor Formation. These strata are generally a stiff to hard, grey sandy silty clay with differing proportions of clay, sand, mottling and laminations. The Upnor Formation soft (top of stratum) to stiff, grey silty sandy slightly with gravelly clay with occasional pockets of silty sand, or as green mottled orangish brown silty becoming clayey sand.

Thanet Sand Formation

4.4.11 The Thanet Sand was described as light brown and grey, silty fine and medium sand with rare burrows infilled with black silt.

White Chalk Subgroup

4.4.12 The top 0.25m was recovered as structureless chalk. Below the chalk was very weak and weak, of medium density with occasional light grey burrows. Fractures were noted to be widely spaced, sub-horizontal, partially open with grey or light brown staining.

Table 4-1 Summary site specific geological profile

Group	Formation	Description of material	Base (mOD)	Thickness of stratum (m)
Superficial deposits				
--	Made Ground	Concrete (0.2 to 0.35m) over a sand and gravel sub base (0.6 to 1.0m). Dark brown clayey sandy gravel with gravel of flint, chalk, brick and clinker.	1.4 to 1.9	2.8 to 3.2
--	Alluvium	Soft brown slightly sandy silty CLAY. Occasional fibrous organic matter and rare shell fragments. A 0.57m thick layer of pseudofibrous peat was encountered north of Bell Lane Creek (SA1105).	0.52 to 1.65	0.3 to 1.45
--	Kempton Park Gravel (River Terrace Deposits)	Very dense to medium dense slightly gravelly SAND to sandy GRAVEL. Gravel of flint.	-1.15 to -2.6	2.15 to 3.4
Bedrock				
Thames Group	London Clay	Firm to very stiff fissured brown to brownish grey slightly sandy silty clay with rare mica and pyrite nodules.	-45.78 to -47.27	43.6 to 46
	Harwich Formation	Very stiff to hard brownish grey sandy slightly gravelly slightly glauconitic clay or silty sand with pockets of lignite.	-46.38 to -46.95	0.58 to 0.6
Lambeth Group	Woolwich and Reading Formations	Stiff to hard grey sandy silty clay. The Upnor formation was described as soft to stiff grey slightly silty sandy gravelly clay.	-66.55	27.75
Thanet Sand		Light brown and grey, silty fine and medium sand with rare burrows infilled with black silt.	-74.8	8.25
White Chalk Subgroup	Seaford Chalk Formation	Very weak to weak white structureless CHALK with occasional flint and bivalves. Widely spaced, partially open fractures with depth.	>-80.05	>5.25

4.5 Site specific hydrogeology

4.5.1 Two groundwater aquifers were encountered. Shallow groundwater within the granular RTD above the London Clay Formation and deeper groundwater in various strata below the London Clay. Water was observed in discrete locations in Made Ground and Alluvium which is likely to be localised perched water.

4.5.2 Groundwater strikes were encountered in all exploratory boreholes, generally at the top of the RTD, at depths between 3.1mbgl and 4.1mbgl. Groundwater was also struck in the Made Ground in SA4502. Standing water levels of between 2.2.m and 3.2m were recorded in the monitoring wells installed on-site. Groundwater strikes and groundwater monitoring data is summarised in Table 4-2.

Table 4-2 Summary of site specific hydrogeological conditions

Formation	Location	Initial strike elevation (mOD)	Stabilised elevation (mOD)	No of monitoring visits	Average elevation (mOD)	Aquifer
Made Ground	SA4502	3.2	3.26	--	--	Perched (non-aquifer)
	SA4507*	0.57	2.24	--	--	
	SA4503	1.33	1.65	3	1.56	
	SA4505*	--	--	5	2.24	
Alluvium	SA1105*	0.52	2.12	--	--	Secondary aquifer – Undifferentiated
	SA4502	0.6	1.41	--	--	
River Terrace Deposits	PR1107*	-0.05	1.65	20	1.87	Secondary aquifer - A
	SA4504B *	0.44	1.82	3	2.04	
	SA4502	--	--	5	1.55	
	SA4505*	1.35	1.75	--	--	
	SA4506*	0.78	2.03	5	2.16	
	SA4507*	--	--	4	2.26	
	SR1108*	--	--	49	2.09	
London Clay	SA1105*	--	--	36	2.45	Unproductive Strata
	SA1105*	--	--	26	2.58	
	SA1106*	--	--	21	-3.95	
	SR1108*	--	--	48	-5.48	
Harwich Formation	PR1107*	--	--	37	-4.74	Secondary aquifer -A
Lambeth Group	SA1106*	--	--	40	-11.58	Secondary aquifer – A
Thanet Sand Formation	--	--	--	--	--	Secondary aquifer - A
Chalk	--	--	--	--	--	Principal aquifer
* Monitoring point located off advanced works site						

4.6 Visual and olfactory evidence of contamination

4.6.1 Made Ground in borehole SA1106 (outside of advanced works area) was recorded to have a slight hydrocarbon odour. This borehole is located in close proximity to an above ground storage tank (AST) and is to the west of the advanced works site (the tanks is a distance from the proposed advanced works).

4.6.2 A slight hydrocarbon odour was noted in borehole SA1105 (located north of Bell Lane Creek) between 7.00m and 7.40mbgl at the base of the RTD. No light or dense non aqueous phase liquid (NAPL) was detected in groundwater during the monitoring visits and during drilling.

4.6.3 No visual or olfactory evidence of hydrocarbon contamination was noted in soils in any of the exploratory holes in the area proposed for the advanced works during the historic investigations. Groundwater samples obtained from SA4502 and SA4503 which are located in Keltbray Yard exhibited probable, or possible, hydrocarbon odour. The chemical analysis of groundwater samples recorded contaminant concentrations as either low or below the method detection limit (based on previous assessments).

4.6.4 The Structural Soils 2011 investigation[10] used a photoionisation detector (PID) to measure volatiles emitted by soil samples at regular intervals during drilling. During the 2014 investigation the PID malfunctioned during the period of pitting and no results are reported.

4.6.5 Non-zero readings ranged from 1.3ppm to 18.1ppm and were recorded from two boreholes (SA4502 and SA4504B). These PID readings are considered to be low and are summarised in Table 4-3.

Table 4-3 Summary of PID readings

Formation	Location	Depth (mOD)	PID measurement (ppm)
Made Ground	SA4502	2.7	1.4
		2.6	2.4
		2.1	18.1
		1.8	1.3
	SA4504B	3.94	4.3
		3.44	3.7

4.6.6 During the 2014 ground investigation both visual and olfactory evidence of contamination were encountered at the west and east ends of TH13, but not throughout the trench. In particular an oily sheen and hydrocarbon odours were recorded during the collection of samples from the eastern edge of TH13 at depths of between 0.5m and 1mbgl.

4.6.7 An oily sheens on perched water and hydrocarbon odours were recorded during the excavation of TH15 at depths of 0.5m and 1.75mbgl. Which was adjacent to western edge of TH13.

4.6.8 During the excavation of the three pits in the foreshore area PID readings of all six samples were taken. All of the PID readings were low with concentrations ranging from <0.1ppm to 0.5ppm; the highest concentration was recorded in FS3 at ground level and corresponds to the faint hydrocarbon odour noted in the log, although this is a very low concentration and within a typical background fluctuation ranage of such equipment.

4.7 Ground gas

4.7.1 Ground gas monitoring was undertaken as part of the Structural Soils 2011 and Fugro 2013 investigations. Gas monitoring was not undertaken as part of the current (2014) investigation which comprised of trial pitting only.

Structural Soils (2011)

4.7.2 Five rounds of ground gas monitoring were completed by Structural Soils over a four week period in 2011. Two boreholes, SA4502 and SA4503, were monitored with response zones within RTD and Made Ground respectively. The monitoring was undertaken under the following pressure conditions:

a. Round 1 (03/03/2011): 1032mbar;

b. Round 2 (08/03/2011): 1019mbar;

c. Round 3 (11/03/2011): 1015mbar;

d. Round 4 (17/03/2011): 1013mbar; and

e. Round 5 (30/03/2011): 1008mbar.

4.7.3 A maximum concentration of methane and carbon dioxide were 2.95 %v/v and 3.3 %v/v respectively (SA4503). A peak flow rate of -26 l/hr was recorded, however it was noted that negative flow rates occurred only in those wells monitoring the RTD and were fully saturated and which were stated as therefore not representative of soil gas flow[10]. A maximum positive flow rate of 0.1 l.hr was recorded.

Fugro 2013

4.7.4 In 2013 Fugro undertook a further round of monitoring from borehole SA6242 and SA6245. The Fugro gas monitoring was undertaken under atmospheric pressure of 1022mbar which is relatively high pressure. The pressure trend over a 24 hour period was not recorded.

4.7.5 The concentrations of methane, from both boreholes, were recorded below detection limit; the maximum carbon dioxide volume was recorded at 0.3% v/v. A gas flow of <0.1l/hr was recorded in both boreholes. Both standpipes were installed with response zones split within the Alluvium/ River Terrace Deposits.

5 Assessment methodology

5.1 Introduction

5.1.1 The UK framework for the assessment of contaminated land endorses the principle of risk assessment and a “suitable for use” approach to contaminated land. Remedial action is only required if there are unacceptable risks to human health or the environment, taking into account the use of the land and its environmental setting.

5.1.2 Risk is a combination of the probability, or frequency, or occurrence of a defined hazard and the magnitude of the consequences of the occurrence. In the context of land contamination, there are three essential elements to any risk:

a. Source (contaminant) – a substance which is located in, on or under the land and has the potential to cause harm to human health, water resources or the wider environment;

b. Pathway – the means or route by which a source of contamination can migrate; an identified receptor can be exposed to, or be affected by an identified source;

c. Receptor – something which could come to harm, including human health, water resources, surface water courses or the wider environment.

5.1.3 Each of these elements can exist independently. They create a potential risk where they are linked together. The linked combination of “source (contaminant) – pathway - receptor” is known as a pollutant linkage. Should a pollutant linkage be identified an assessment is made as to whether the risk is acceptable or not.

5.1.4 The technical framework for applying a risk management process for considering land affected by contamination is described by the Model Procedures, CLR11[1]. This is applicable to a range of non-regulatory and regulatory contexts and provides a consistent framework for decision making.

5.1.5 The basic risk management process in the Model Procedures has three main components:

a. Risk assessment – establishing whether unacceptable risks exist and, if so, what further action needs to be taken in relation to the site;

b. Options appraisal – evaluating feasible remediation options and determining the most appropriate remediation strategy for the site;

c. Implementation – carrying out the remediation strategy and demonstrating that it is, and will continue to be, effective.

5.1.6 Within CLR11, risk assessment is a tiered approach from preliminary risk assessment (PRA) with the development of a conceptual site model

(CSM), to generic quantitative risk assessment (GQRA) through to the site specific detailed quantitative risk assessment (DQRA).

5.2 Human health risk assessment methodology

5.2.1 To simplify the assessment of ground contamination risks, the Statutory Guidance suggests that generic soil quality guideline values may be used for initial screening of soil contamination testing results. Such values can also be used for the assessment of land contamination with respect to the Planning Regime.

5.2.2 Generic assessment criteria (GAC) and site-specific assessment criteria (SSAC) can be calculated using the software version of the Contaminated Land Exposure Assessment (CLEA) model[12,13]. The model estimates human exposure (children and adults) to soil contaminants for those potentially living, working and/or playing on contaminated sites over long time periods (chronic exposure). The CLEA model does not consider short-term (acute) risks to humans, such as those which may arise during construction activities, or the risks posed by contaminated groundwater.

5.2.3 Thames Tideway Tunnel has developed a set of GAC for each of the land use scenarios for a wide range of common contaminants of concern. GAC for a commercial end use have been used in this assessment.

5.2.4 A Defra research project to provide new technical tool to support the revised statutory guidance produced Category 4 Screening Values (C4SLs) for four generic land-uses for six substances[14]. C4SLs are precautionary and describe a level of risk that whilst above “minimal” (typically used for GAC derivation) is still low. Both DCLG and Defra have confirmed in writing that it is government policy that C4SLs can be used within the planning regime[15]. Arup has considered the use of the C4SLs within this GQRA and in most cases that has not been necessary, although some comment is made with respect lead and benzo(a)pyrene. Considering the conceptual model the C4SL for lead has simply been used to benchmark the existing data against that “acceptably low” criterion. In this case the assessment and mitigation is principally based on prevention of exposure defined in the conceptual model and does not rely on the C4SL being a “safe” level.

[12] Environment Agency, 2009, Science Report SC050021/SR2, Human Health Toxicological Assessment of Contaminants in Soil

[13] Environment Agency, 2009, Science RerportSC050021/SR3, Updated Technical Background to the CLEA Model

[14] http://randd.defra.gov.uk/Default.aspx?Module=More&Location=None&ProjectID=18341 [accessed 28/11/14]

[15] http://planningguidance.planningportal.gov.uk/blog/guidance/land-affected-by-contamination/land-affected-by-contamination-guidance [accessed 28/11/14]

5.3 Controlled waters risk assessment methodology

5.3.1 As described by the Environment Agency's Groundwater Principles and Practice (GP3)[16], a tiered approach should also be undertaken when considering risks to controlled waters. This is as follows:

a. Tier 1 Qualitative risk screening (QRS): Qualitative risk screening helps work out whether the activity needs more detailed assessment.

b. Tier 2 Generic quantitative risk assessment (GQRA): A generic quantitative risk assessment (Tier 2) should be carried out when the previous qualitative risk screening (Tier 1) is insufficient for us to make an informed decision on the risk posed by the site.

c. Tier 3 Detailed quantitative risk assessment (DQRA): Detailed quantitative assessments should be carried out where it is clear that there are definite S-P-R linkages.

5.3.2 In general when undertaking a GQRA, groundwater results are initially screened against Environmental Quality Standards (EQS) to identify potential contaminants of concern. Separate standards exist for fresh surface waters and for drinking water standards (DWS) and the appropriate standards are selected based on the receptor. Certain EQS values vary based on the hardness of the receiving water. Where no UK values are available the results can be compared to other appropriate water quality standards. Thames Tideway Tunnel has developed a standard list of water quality standards that have been applied in this case.

5.3.3 DQRA is a site specific approach, utilising site data and involves probabilistic modelling, taking into account fate and transport properties, aquifer properties and contaminant degradation. A sensitivity analysis is a key aspect of this process to provide a credible basis for decision making and to see how parameters vary and affect the outcome. Various models are available to undertake this including the Environment Agency's Remedial Targets Methodology[17].

5.3.4 In this case a simple tier one assessment has been undertaken as the conceptual model and proposed construction methodology for these advanced works do not result in any unacceptable risks to controlled waters.

5.4 Conceptual model and pollutant linkages

Development of conceptual model

5.4.1 A conceptual model consists of three elements, source, pathway and receptor:

[16] Environment Agency, 2013, Groundwater Principles and Practice (GP3)

[17] Environment Agency, 2006, Remedial Targets Methodology: Hydrogeological Risk Assessment for Land Contamination

a. *Sources (S) are potential or known contaminant sources such as a tank or know area of contamination in the ground.*

b. *Pathways (P) are environmental systems thorough which a contaminant could migrate e.g. air, groundwater*

c. *Receptors (R) are sensitive environmental receptors that could be adversely affected by a contaminant e.g. site occupiers, groundwater resources.*

5.4.2 A plausible pollutant linkage exists if all elements co-exist. An assessment of the source-pathway-receptor linkages has been undertaken for the site.

Summary of preliminary conceptual model

5.4.3 A conceptual model was developed by Mott MacDonald and is presented within the Phase 2 Contamination Assessment report[3]. This is reproduced in Appendix F. An updated conceptual model is presented in Section 6 based on the advanced works and incorporates the latest investigation findings.

6 Updated conceptual model

6.1 Introduction

6.1.1 The conceptual model (the model) considers the construction phase and the site in the period following construction and the main shaft construction. A separate risk assessment will be developed for the latter works.

6.1.2 The proposed works are described in detail in Section 3 and drawings showing the construction details are included in Appendix C. In summary the advanced works will include the demolition of existing site structures, (weigh-station, warehouse, gatehouse, boundary wall and substation building) along with a section of the existing river wall and the construction of a new section of river wall. The weigh-station will be reinstated with temporary hardstanding in preparation of the TTT main shaft construction works.

6.1.3 Once construction of the advanced works is complete the site will be predominantly unoccupied until the main TTT shaft construction works begin. In this interim period the site will be hardstanding and accessed for short periods by contractors and consultants. The new electrical substation may be occasionally accessed by an engineer to undertake maintenance work.

6.1.4 This model has been developed specifically for the areas and activities associated with the advanced works only (i.e. it is very specific to the locality of intrusive works such as piling and ground break). It is not intended to be an assessment of the wider Keltbray Yard or Dormay Street site as that will be considered by subsequent risk assessments.

6.2 Sources

6.2.1 The following sources of contamination have been identified and included in the conceptual site model:

a. Made Ground and perched water affected by historical contamination including foreshore soils **(S1)**;

b. Shallow groundwater impacted by historical contamination (from on and offsite) **(S2);**

c. Stockpiles of Made Ground during construction **(S3);** and

d. Organic rich/ peaty alluvium which is a potential source of gases **(S4).**

S1 – Made Ground and foreshore soils

6.2.2 The site and surrounding area has historically been developed since at least the mid 19th Century. A summary of the review of site history is presented in Section 2.4. Keltbray Yard was a malthouse in mid 19th Century, a laundry between c1896 and c1916 and, until recently, was

developed as various works and used most recently as a bus depot. An electrical substation is located in the north of Keltbray Yard.

6.2.3 Made Ground was identified in all exploratory holes within the site and surrounding area and ranged in thickness from 2.8 to 3.2m. Within Keltbray Yard this was described as containing concrete, brick and clinker. Soil vapours, detected using a PID, ranged from 1.3 to 18.1ppm. Hydrocarbon odours and visual evidence of hydrocarbon was noted in the area of the river wall works in the upper metre of Made Ground. A faint hydrocarbon odour was noted during the excavation of one of the pits in the foreshore area.

6.2.4 No above ground storage tanks are shown on historical mapping, however, maltkilns are shown in mapping from 1864 and were misidentified as tanks in the Geotechnical Desk Study[4].

6.2.5 Made Ground is present between 2.8 and 3.2m thick across the site. This was described as dark brown which may indicate organic matter content however no organic fragments, such as plant, roots, wood, were described. Organic matter may breakdown and generate ground gases such as methane and carbon dioxide.

S2 - Shallow groundwater

6.2.6 Shallow groundwater may contain concentrations of dissolved contaminants derived from leachate from the overlying Made Ground soils or dissolved from oils for instance.

6.2.7 No evidence of hydrocarbon contamination (free oil, sheens or odours) was noted during drilling of the boreholes in Keltbray yard. Monitoring for free phase contamination did not detect LNAPL or DNAPL in any of the monitoring installations. A slight hydrocarbon odour was noted on one groundwater monitoring visit in boreholes SA4502 and SA4503 (located on Keltbray Yard).

S3 – Made Ground excavation and stockpiles

6.2.8 Made Ground material will be excavated during construction of the river wall and will arise form piling. A small volume of soil may be removed from beneath the weigh-station to provide space for a sub base for the reinstated hardstanding. This excavated material may be temporarily stockpiled during the construction works before being transported off site. The stockpiles may dry out and act as a source of soil dust.

6.2.9 During periods of rainfall, or where the material is damped down to reduce fugitive dust emissions, run off may be generated.

S4 – Alluvium

6.2.10 A relatively thin layer of Alluvium was encountered below Made Ground across the site. The material was locally described as black peaty organic clay and frequently contained roots and rootlets. To the north of Bell Lane Creek (borehole SA1105) a layer of spongy black pseudofibrous peat was encountered above a layer of peaty clay with roots and rootlets.

6.2.11 The Alluvium may be a source of methane and carbon dioxide. The gas generating potential of this material (0.3 to 1.45m thick) is likely to be low[18].

6.3 Receptors

Environmental receptors at the site are summarised below:

a. Construction workers (**R1**);

b. Users of adjacent site during construction (**R2**);

c. Users of the site in the period following completion of the advanced works (**R3**);

d. Surface waters (**R4**);

e. Upper aquifer (Secondary A aquifer) (**R5**)

f. Lower aquifer (Principal aquifer) (**R6**);

g. Ecology (**R7**).

R1 – Construction workers

6.3.2 The principal human receptors at the site during the construction phase will be the site workers and other site staff involved in the construction works. All site personnel will be required to follow site health and safety procedures and it will be compulsory for staff to wear PPE appropriate for the work they are undertaking.

R2 – Users of neighbouring sites

6.3.3 Users of neighbouring sites may become exposed to contaminant emissions (dust) during the construction phase if dust is not controlled.

R3 - Future site users

6.3.4 The site will be accessed for short periods during the period following the advanced works and the main shaft construction phase. Access will be controlled and will be limited to contractors or consultants.

R4 – Surface water

6.3.5 Surface water receptors include Bell Lane Creek, the River Wandle and the tidal River Thames.

R5 – Upper (Secondary A) aquifer

6.3.6 The upper aquifer is designated as a Secondary A aquifer by the EA. This aquifer is considered to provide baseflow to the nearby River Thames and tributaries, including Bell Lane Creek and River Wandle which are adjacent to the site.

[18] S Wilson, G Card and S Haines, 2009, Ground Gas Handbook

R6 – Lower (Principal) aquifer

6.3.7 The lower aquifer is the most sensitive groundwater receptor and this is classified as a Principal aquifer.

R7 - Ecology

6.3.8 Vegetation and fauna inhabiting the new ecological terrace adjacent to the new river wall are a potential receptor. The surface water adjacent to the site is classed as a Site of Importance for Nature Conservation (SINC) Grade M.

6.4 Pathways

6.4.1 The following pathways have potential to link the sources of contamination with the receptors identified described above.

Human health

6.4.2 During the construction phase the following pathways may result in exposure to contaminants:

a. Ingestion of soil, soil dust and shallow groundwater (P1)
b. Inhalation of soil dust (P2)
c. Inhalation of vapours and ground gases (P3)
d. Dermal contact with soil, soil dust and shallow groundwater (P4);
e. Accumulation of hazardous gases to asphyxiating/ toxic concentrations (P5);
f. Accumulation of hazardous gases to explosive concentrations (P6).

6.4.3 Users of nearby sites may become exposed to soil dust (P2).

6.4.4 Once the advanced works have been completed the site will be covered by the existing hardstanding and temporary hardstanding and therefore a number of the pathways described above will be removed (P1, P2, and P4).

6.4.5 Access to the site will be controlled and will be limited to contractors or consultants for short periods. Site visitors may be exposed to contaminants via inhalation of soil or groundwater vapours (P3). There will be no accessible structures or confined spaces. Consequently any vapours (P3) or ground gases (P5 and P6) reaching the ground surface will be significantly diluted by the ambient air. Consequently this pathway is not considered further.

Controlled waters

6.4.6 The following pathways may transport contamination to controlled waters:

a. Leaching of contaminants and recharge into groundwater (P7);
b. Lateral migration of dissolved contamination in groundwater (P8);

c. Vertical migration of dissolved contamination in groundwater (P9);

d. Vertical migration of groundwater along the river wall piles (P10);

e. Lateral flow of run-off along the ground surface (P11); and

f. Disturbance of contamination during foreshore works and migration to surface water (P12).

6.4.7 Rainfall percolating through Made Ground may leach contaminants which can then recharge shallow groundwater (upper aquifer) and introduce contaminants to groundwater (P7). However rainfall infiltration will be significantly reduced by new hardstanding which will cover the areas that are part of the advanced works following completion of the works. Consequently this pathway (P7) is not considered further in this assessment.

6.4.8 During the construction works the existing hardstanding will be locally removed at the weigh-station and between the old and new river walls. This will be for a very short time and in a small part of the site (very small area). Following construction the hard standing is reinstated and the base of the wall excavation capped. The potential for leaching of contaminants from these small areas to have a significant effect on groundwater or surface water in the short period of time is very low and insignificant. Consequently this pathway (P7) is not considered further in this assessment.

6.4.9 The upper aquifer is considered to be in hydraulic continuity with the tidal River Thames and its tributaries, including Bell Lane Creek and the River Wandle (except where it may be cut off by the existing River Wall). Groundwater flowing laterally may transport dissolved contaminants from the site towards these receptors (P8). The River wall works will remove Made Ground from in front of the new wall (after the wall has been installed and cut off that area) which will then be capped with a concrete shelf. The new wall will cut off residual Made Ground behind the wall from the surface water (in this area). The new river wall will not create any new pathways (CFA piling keyed into the London Clay). Therefore, in respect to the areas being assessed in this report, and the extent that the advance works may affect the ground (which is very limited) P8 is not considered any further.

6.4.10 The piling will be either CFA (which does not create new vertical pathways) or cased bored piles. The casing cuts off the pile construction and will be keyed into the London Clay. The lower aquifer is separated from the upper aquifer by more than 43m of low permeability London Clay which will restrict this flow (P9). Consequently this pathway is not considered further.

6.4.11 Drilling and installation of the new piled flood wall may act as a preferential pathway for downwards groundwater flow (P10). The toe of the new wall will be installed within the uppermost 15m, of the London Clay (toe level is approximately -15mOD). Consequently there will be no new pathway into the lower aquifer (P10) and this pathway is not considered further.

6.4.12 There is a possibility for rainwater to interact with stockpiles contamination which may then flow along the ground surface towards and enter Bell Lane Creek (P11).

6.4.13 During the foreshore excavation works there is a potential for existing contamination (if it exists) to be disturbed (P12). The works will comprise a shallow excavation which will then be infilled with a geotextile filter membrane and imported rock armour stone.

Ecology

6.4.14 The new terrace will form naturally over a concrete shelf and be separated from the site by the new concrete river wall. The concrete will therefore provide a barrier preventing a pathway linking site contaminants and vegetation and fauna (P12) within this new habitat. Consequently this pathway is not considered further. The piled wall will form a new effective cut off and prevent any new migration of contamination off site in the area of those advanced works (P8).

6.5 Plausible pollutant linkages

6.5.1 A summary of the plausible pollutant linkages (PPL) is summarised in the table below. This is based on the site CSM described above.

Table 6 1 Plausible pollutant linkages

Source	Pathway	Receptor
Construction Phase		
S1: Made Ground soils	P1: Ingestion of soil and soil dust P2: inhalation of soil dust P3: Inhalation of gas and vapours P4:Dermal contact with soil and soil dust	R1: Construction workers
S2: Shallow groundwater	P1: Ingestion of water P3: inhalation of vapours P4: Dermal contact with water	R1: Construction workers
S3: Made Ground soil dust (stockpiles)	P1: Ingestion of soil and soil dust P2: inhalation of soil dust P4:Dermal contact with soil and soil dust	R1: Construction workers R2: Users of nearby sites (P2 only)
S1 Foreshore soils	P12 Disturbance of contamination during excavation	R4: Bell Lane Creek
S4: Run of from stockpiles	P11: Flow of run-off along ground surface	R4: Bell Lane Creek
Post Construction		
S1: Made Ground soils	P3: Inhalation of soil vapours	R2: Future site users (maintenance worker)
S2: Shallow groundwater	P3: Inhalation of soil vapours	R2: Future site users (maintenance workers)

7 Human health risk assessment

7.1 Summary of plausible pollutant linkages

7.1.1 Due to the limited nature of the works, and the manner they will be undertaken and finished, the residual PPLs related to human health requiring further assessment are limited to those associated with the construction phase and gas and vapour inhalation during operation. These are summarised below:

a. Exposure of construction workers to Made Ground (either in ground or temporary stockpiles) soils via dermal contact, inhalation of soil dust and vapours, ingestion of soil;

b. Exposure of construction workers to shallow groundwater via dermal contact, inhalation of vapours, ingestion;

c. Exposure of users of neighbouring sites to dusts originating from Made Ground or stockpiles via inhalation of soil dust;

d. Inhalation of soil vapours or gases from Made Ground or Alluvium by future site users; and

e. Inhalation of shallow groundwater vapours by future site users.

7.1.2 The risk associated with these PPLs are considered in the following sections. Risks posed by ground gases are assessed separately in Section 9.

7.2 Generic Quantitative Risk Assessment (GQRA)

7.2.1 Following the tiered approach outlined in CLR11[1] a generic quantitative risk assessment (GQRA) has been undertaken to provide an initial assessment of the risks to human health. There are no published generic assessment criteria (GAC) for assessing the short term exposure of construction workers or neighbours to contaminated soils etc. In the absence of such criteria the results have initially been benchmarked by comparison to commercial GAC. These assess the risk of harm to office workers, exposure on a daily basis for their entire lives to both outdoor and indoor contamination and include ingestion, dermal contact and inhalation of soils, soil dust and hydrocarbon vapours. They do not include risks to groundwater contact etc.

7.2.2 Once the advanced works have been completed the site will be largely unoccupied with the exception of occasional visits from contractors/ consultants. The site will be covered by hard standing. During construction there is an embedded level of protection for construction workers who are required to comply with the CoCP. Therefore in both cases the initial screen of data is considered conservative and results above the GAC do not necessarily represent significant contamination rather further assessment is required.

Results

7.2.3 The screening assessment table is presented in Appendix G. In general the soil concentrations are significantly lower than the commercial assessment criteria.

7.2.4 One sample exceeded the criteria for lead (based on the C4SL of 2,330mg/kg). This was recorded in hole TH13 at 0.3mbgl where the lead concentration was 18,300 mg/kg. In the remaining 11 samples the lead concentration ranged from between 27mg/kg and 954mg/kg and is therefore relatively low. Of the six samples collected from the foreshore area, one recorded a lead concentration of 3,600 mg/kg and is therefore in excess of C4SL. In the remaining five samples the lead concentrations ranged from 19mg/kg to 1000mg/kg.

7.2.5 The commercial criteria for benzo(a)pyrene (14mg/kg) was exceeded in sample TH13 at 0.5mbgl. The recorded concentration was 22.3mg/kg. It is noted that this concentration is well below the C4SL published by Defra of 76mg/kg. Benzo(a)pyrene was recorded less than the laboratory detection level (0.01mg/kg) in seven locations and ranged between 0.18mg/kg and 2.75mg/kg in the remaining four locations. Benzo(a)pyrene was recorded at less than the laboratory detection level in five of the six samples taken from the foreshore area; one detectatble benzo(a)pyrene concentration was reacorded at 0.93mg/kg.

7.2.6 No other contaminants exceeded the assessment criteria.

7.2.7 Certain hydrocarbon fractions exceeded their theoretical soil saturation limit (but not the assessment criteria). This may provide an indication that some free phase hydrocarbon may be present in the ground. A sheen and odour was identified in the upper 1m during the excavation of TH13 and TH15. The CLEA model does not assess the risk from hydrocarbons that are in free product and some additional precautions will be warranted in that respect. All of the TPH concentrations recorded from the foreshore area were low (ranging from <5.0 to 13 mg/kg for TPH) with the majority being recorded at below detection limit.

7.2.8 Eighteen samples were selected for asbestos identification. No asbestos was identified in the samples selected for testing, including those from the foreshore. Asbestos fibres or asbestos containing materials (ACM) were not identified. There is still a potential for encountering ACM and asbestos fibres.

Summary of FES results

7.2.9 In general the chemical results were very low and in a lot of cases well below the commercial screening criteria. SA6245 at a depth of 0.5mbgl reported slightly elevated PAH concentrations (total PAH up to 160mg/kg) but all speciated results were below GAC. In addition, all of the soil and water samples collected were tested for a chlorinated solvent suite. The majority of these samples recorded concentrations below the low detection limit. One soil sample reported detectable, but very low, concentrations of trans-1,2-dichloroethylene (0.02mg/kg), tetrachloroethylene (0.79mg/kg)

and trichloroethylene (0.06mg/kg). There are no specific published GAC for these compounds but the concentrations are either the same order of magnitude, or an order of magnitude below, the most conservative GAC for one of the most toxic chlorinated solvents (1,2-Dichloroethane (0.7mg/kg)).

7.2.10 The FES testing included an asbestos screen using microscopy on three samples of Made Ground. No asbestos was detected in the samples tested.

Summary of Structural Soil results

7.2.11 In general, metal concentrations were consistently low with most falling well below commercial screening criteria and a high proportion below method detection limits. One sample (SA4504B) taken from southern edge of the wider site reported slightly elevated lead (1,050mg/kg) concentration, but this is less than the GAC used.

7.2.12 The concentrations of PAH (in comparison to other on-site samples) were slightly elevated but still below commercial thresholds.

7.2.13 Seven selected samples of Made Ground were screened for asbestos containing materials (ACM) by visual inspection. This testing did not identify ACM however it is noted that testing requirements have recently changed and this type of screening is no longer valid for as a method for assessing the absence of asbestos.

7.3 Statistical analysis

7.3.1 A statistical analysis of the results is not warranted based on the conceptual model.

7.4 Outlier treatment

7.4.1 A statistical analysis of the results is not warranted based on the conceptual model.

7.5 Method detection limits

7.5.1 A statistical analysis of the results is not warranted based on the conceptual model.

7.6 Qualitative risk assessment

7.6.1 A qualitative risk assessment has been undertaken following the guidance outlined in CIRIA C552[19]. This assessment is based on the model and considers the findings of the GQRA.

[19] CIRIA, 2001, C552: Contaminated land risk assessment - a guide to good practice

Post Construction

7.6.2 Lead and benzo(a)pyrene were detected at concentrations which exceed the GAC in TH13 at 0.3mbgl and 0.5mbgl respectively and in FS3 at 0mbgl in for foreshore. All other results were below GAC and not likely to present a risk of harm to end users.

7.6.3 The CSM has identified that the vapour pathway is the only PPL for exposure to soils. No volatile contaminants have been identified.

7.6.4 The risk of harm to end users arising from the proposed advanced works is considered very low.

Groundwater

7.6.5 Hydrocarbon odours were noted in certain locations during the investigation and the CSM has identified a PPL linking future site users with shallow groundwater contamination via inhalation of vapours.

7.6.6 There will be no accessible structures or confined spaces proposed on site (in relation to the riverwall works, foreshore works or other activfties assessed in this report). Consequently any vapours reaching the ground surface will be significantly diluted by the ambient air.

7.6.7 Shallow groundwater was not encountered in TH14, which was positioned in the position of the proposed substation. Groundwater test results from locations elsewhere within the site (see Section 8) show very low concentrations of most organic contaminants. Groundwater sampled from TH15 (20m to the west) recorded aliphatic hydrocarbon fractions greater than C_{12} and aromatic hydrocarbon fractions greater than C_{10} above detection. The concentrations were relatively low.

Construction phase

7.6.8 A plausible pollutant linkage has been identified in the conceptual model relating to construction workers and users of nearby sites during the excavation of potentially contaminated soils during the construction work.

7.6.9 The concentrations of most contaminants measured from the soil testing were below values that might be regarded as posing an acute risk to construction workers, however, elevated lead was identified in two samples. Slightly elevated PAH was also identified above GAC but below C4SL. No ACM or asbestos was identified. There is the potential for low levels of asbestos fibres and occasional ACM to be encountered.

7.6.10 It is recommended that precautions are taken to reduce potential exposure in accordance with the principle of ‘as low as reasonably practicable’ (ALARP). This should include additional appropriate staff briefings on lead, hydrocarbons and (potential for) asbestos. The CoCP sets out general health and safety procedures for construction works. Exposure should be limited by use of PPE, hygiene procedures and good site practice. Further details are provided in section 11.

7.6.11 The risk to users of adjacent sites during the construction phase is controlled by exposure to contaminants via inhalation of fugitive dust

particles. Dust suppression should be undertaken during construction activities.

7.6.12 Assuming appropriate construction practices during development the risk of harm to construction workers and neighbours during construction is very Low. Further details on the risk management procedures are provided in section 12.

7.7 DQRA

7.7.1 No further assessment is required

8 Controlled waters risk assessment

8.1 Summary of plausible pollutant linkages

8.1.1 The conceptual model has confirmed that due to the limited nature of the works proposed and methods that will be used during construction the advanced works will not result in many residual PPLs related to controlled waters that require further quantitative assessment for these works. The site for the main TTT construction works will be assessed as a whole at a later stage. There are two residual PPL relating to risks to controlled waters:

a. Flow of run-off from temporary stockpiles into surface waters; and

b. Distrubance of contamination in foreshore during excavation.

8.1.2 These PPL will be dealt with using additional risk management procedures during the construction phase which are described further in Section 11. A brief assessment of soil leachability results and surface water results has been undertaken to provide an indication of available (leachable) contaminants within the soil and quality of water in the creek.

8.1.3 The general soil testing (solids rather than leachability) did not indicate any concentrations of hydrocarbons in the foreshore soils, and in fact those concentrations were very low. This indicates that issues associated with ‘free prodcut’ or non-aqueos phase liquids (NAPL) are unlikely although a watching brief should be maintained.

8.2 GQRA

8.2.1 This stage involves screening of water quality data against environmental standards. This first tier of assessment does not account for any attenuation of contamination between source and receptor or any other site specific factors.

8.2.2 Leachability testing is undertaken following a standard laboratory procedure and testing of the eluate provides a prediction of the dissolved concentrations which may be released from soils.

Screening criteria

8.2.3 Separate environmental standards exist for surface water and for groundwater.

8.2.4 Thames Tideway Tunnels have specified the environmental standards for screening for controlled waters risk assessments. The following hierarchy has been used in the assessment:

a. Freshwater EQS

b. Coastal/ Transitional Water EQS

c. UK Drinking Water Standards (UK DWS)

d. World Health Organisation Water Standards (WHO).

8.2.5 The use of drinking water and freshwater EQS is very conservative for this site as there are no drinking water receptors and the River Thames is tidal to the north of the site and therefore is likely to be coastal/ transitional water.

Results

8.2.6 Eighteen samples of Made Ground were selected for leachability testing for metals, chloride, fluoride, sulphate and phenol.

8.2.7 Most metals and inorganics reported low leachability concentrations that were below the relevant water quality standards. Leachable concentrations of arsenic, chromium, copper, lead and sulphate slightly exceeded the environmental standards (based on most conservative EQS initial screening). The initial assessment is presented in Appendix G and those exceeding the summarised in Table 8-1

Table 8-1 Summary of Leachate Screening Assessment

Contaminant	Screening Criteria (mg/l)	Location	Depth (mbgl)	Concentration (mg/l)
Arsenic	0.01 (EQS)	TH15	2.7	0.02
		TH12	2.3	0.04
		TH12	1.5	0.02
Chromium	0.0006 (EQS)	TH14	0.3	0.007
		FS1	1.0	0.002
		FS2	1.0	0.005
		FS3	0.0	0.006
		FS3	1.0	0.004
Copper	0.005 (EQS)	TH15	0.5	0.01
			2.7	0.04
		TH14	0.75	0.01
		TH13 (P5)	0.5	0.03
			1.1	0.03
		TH13 (P2)	0.45	0.01
		TH12	0.75	0.02
			2.3	0.01
			1.5	0.01
Lead	0.0072 (EQS)	TH14	0.3	0.011
Sulphate	250 (EQS)	TH14	0.3	358
		TH14	0.75	826
		TH13 (P3)	0.3	357

8.2.8 The results (described above) which are higher than the most conservative EQS are all relativerly low. For instance five results (including four from the foreshore) are shown above the chromium EQS. However that particular EQS is based on chromium VI (for the annual mean), and while a speciated result is not available it is considered very unlikely that the form of chromium would be hexavalent, based on site use,the environmental condtions and age. Most of the chromium results would be below the EQS for chromium III (which is an order of magnitude higher (for an annual mean, and all would be well below the standard for 95th percentage results)).

8.2.9 In a similar fasion the initial EQS for copper (0.005mg/l) is low. The hardenss ($CaCO_3$) level reported in the Creek was over 300mg/l. Based on this, many of the copper results would be below or of a very similar magnitude (slightly above) a revised EQS. All results would be below EQS for protection of fisheries (Salmonid Waters) at this level of hardness.

8.2.10 Similar assessments apply to both arsenic and lead. Overall th leachability results are relatively low (considering direct worst case direct percolation of water/ soil portioned results (without any further consideration of attenuation, degradation or dilution)). This includes the results from the foreshore which were generally very low.

8.2.11 Two samples of shallow perched water were obtained from within the trial pits during excavation. These samples were taken when excavating the pit and are intended to be generally indicative of the perched water in those locations. This type of sampling does not represent the deeper groundwater in the aquifers which was not included in the recent investigation due to the limited nature of the advance works. It is not unusual that samples taken in this manner may be cross contaminated as water runs into the pit over various surfaces and soils falls into the water.

8.2.12 The water samples recorded concentrations of copper, mercury, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene and certain aliphatic and aromatic hydrocarbon fractions above the screening criteria.

8.2.13 The screening assessment is presented in Appendix G and summarised in Table 8-2

Table 8-2 Summary of Groundwater Screening Assessment

Contaminant	Screening Criteria (mg/l)	Location	Depth (mbgl)	Concentration (mg/l)
Copper	0.005 (EQS)	TH12	?	0.018
Mercury	0.05 (EQS)	TH12	?	0.17
Acenaphthylene	0.00001 (EQS Benzo(a)pyrene)	TH15	1.8	0.0078
Acenaphthene	0.00001 (EQS Benzo(a)pyrene)	TH15	1.8	0.00632
Fluorene	0.00001 (EQS Benzo(a)pyrene)	TH15	1.8	0.0087
Phenanthrene	0.00001 (EQS Benzo(a)pyrene)	TH15	1.8	0.0053
Anthracene	0.00001 (EQS)	TH15	1.8	0.0017
Aliphatic EC12 to 16	0.01 (UK DWS)	TH15	1.8	0.057
Aliphatic EC16 to 21	0.01 (UK DWS)	TH15	1.8	0.095
Aliphatic EC21 to 35	0.01 (UK DWS)	TH15	1.8	0.030
Aliphatic EC8 to 35	0.01 (UK DWS)	TH15	1.8	0.182
Aromatic EC10 to 12	0.01 (UK DWS)	TH15	1.8	0.084
Aromatic EC12 to 16	0.01 (UK DWS)	TH15	1.8	0.305
Aromatic EC16 to 21	0.01 (UK DWS)	TH15	1.8	0.108
Aromatic EC8 to 35	0.01 (UK DWS)	TH15	1.8	0.497
Total Petroleum Hydrocarbons	0.01 (UK DWS)	TH15	1.8	0.679

8.2.14 Two surface water samples were taken from the north of the site from Bell Lane Creek. SW1 was located in close proximity to where the foreshore

soil samples were taken from and SW2 was taken, north of the site, just riverward of the weir in the mouth of Bell Lane Creek.

8.2.15 One of the water samples, taken from SW2, at the mouth of Bell Lane Creek recorded a concentration of chromium (9.3ug/l) in excess of the initial EQS screening critera (5ug/l). All other concentrations were recorded within EQS with the majority of samples being recorded below detection limt. Assuming this results represent chromium III rather than the hexavant form then this result is below the relavant EQS.

8.3 Qualitative risk assessment

8.3.1 A qualitative risk assessment has been undertaken following the guidance outlined in CIRIA C552[19]. This assessment is based on the CSM and considers the findings of the GQRA.

Construction phase

8.3.2 Piling, which may cause a preferential follow path through the London Clay will terminate within the uppermost c.15m of the London Clay and hence no pathway will be created. The technique proposed is CFA which prevents any significant impact of the shallow aquifer.

8.3.3 A plausible pollutant linkage has been identified between stockpiles of Made Ground and nearby surface waters (Bell Lane Creek and River Wandle).

8.3.4 Made Ground excavated as part of the advanced works is likely to be in relatively small quantities and will be temporary. Some excavation works will be directly adjacent to the surface water. The stockpiles will be damped down to reduce fugitive dust or will be naturally damped by rain. Consequently there is a potential for run off which can flow across the ground surface. Run off might contain leachable metals and inorganics, the dissolved fraction of less soluble hydrocarbons, or carry dissolved hydrocarbons and sediment towards the surface water receptor.

8.3.5 It is considered that the risk of significant pollution of controlled waters arising from run off is low. The risk reduces further with the implementation of effective stockpile management and pollution prevention measures such as bunding which will further reduce this to a very low risk. A designated area for the stockpiles should be identified.

8.3.6 Stockpiles should be positioned away from Bell Lane Creek and River Wandle to reduce the potential for run-off entering these receptors.

Post construction

8.3.7 No post construction controlled water PPLs were identified (see Section 6.5) for the following reasons:

a. The works will involve removal of Made Ground between the new and existing river wall removing this potential leachate source in the area where most of the intrusive works are taking place;

b. The new river wall will act as a cut-off wall (keyed into the low permeability London Clay) and create a longer flow path towards the surface water receptors;

c. The site will be covered by existing hardstanding and reinstated temporary hardstanding which will prevent infiltration (and hence leaching potential) after construction;

d. The lower aquifer is separated from the site by a layer of London Clay which is approximately 43m thick at the site and this low permeability strata will prevent vertical migration of contamination from the surface;

e. Piling, which may cause a preferential flow path through the London Clay which will terminate within the uppermost c.15m of the London Clay.

8.4 DQRA

8.4.1 No further assessment is required

9 Gas risk assessment

9.1 Methodology

9.1.1 Following the principles outlined in CLR11[1], the risk posed by ground gases is assessed following a tiered approach. Initially this is assessed via a conceptual site model which considers whether a plausible pollutant linkage exists relating to ground gases. If a PPL is identified then the risk is quantified using ground gas monitoring data. Typically this is done by following one of the two methods described within CIRIA C665[20].

9.1.2 This method involves the derivation of gas screening value (GSV) for methane and carbon dioxide using the following calculation; GSV = borehole soil gas flow rate (l/h) x gas concentration/100 (%v/v). The calculated GSV is then used to determine whether remedial measures are required.

9.1.3 Gas monitoring was not undertaken as part of the 2014 investigation which consisted of trial pits to infill gaps in the advanced works area. Gas monitoring was undertaken as part of the Structural Soils (2011) and Fugro (2013) investigations.

9.1.4 During the structural soils ground investigation the maxium positive flow rate (0.1 l/hr) and the maximum recorded concentrations of methane (2.95% v/v) and carbon dioxide (3.3% v/v) correspond to a GSV for both methane and carbon dioxide of 0.003 which falls witin characteristic situation (CS) 1 (the lowest category for which no gas protection is typically required). The limited ground gas monitoting completed during the Fugro (2013) ground investigation also resulted in a CS1 classification. All GSVs are indicative of a site posing a very low risk from ground gas. Methane concentrations, recorded during the Structural Soils ground investigation, were recorded in excess of 1% v/v. According to published guidance (summarised in the Ground Gas Handbook[21]) the assessor should consider increasing the classification to CS2 if concentrations of methane exceed 1% by volume or carbon dioxide concentrations exceed 5% by volume.

9.2 Summary of plausible pollutant linkages

9.2.1 A summary of the plausible pollutant linkages is given in Table 6.1; no plausible pollutant linkages have been identified at the site as there will be no confined spaces and any gases reaching the ground surface will be significantly diluted by the ambient air.

[20] CIRIA (2007) Assessing Risks Posed By Hazardous Ground Gases to Buildings (C665)

[21] Wilson, Card & Haines (2009), Ground Gas Handbook, Whittles Publishing, Caithness, Scotland

10 Waste

10.1 Introduction

10.1.1 There is limited potential for re-using soils excavated as part of the advanced works within the site. Consequently the limited volumes of material that will be excavated (mainly concrete hardstanding and residual soil between the new and old river wall), will require transport off site and it may be most appropriate to dispose of this at landfill.

10.1.2 As this material will be classified as a waste, the waste classification has been assessed in accordance with Environment Agency guidance WM2[22] and Waste Acceptance Criteria (WAC) testing has been considered to provide an indication of the category of landfill which could accept the waste. Further testing will be required prior to disposal if landfill is determined to be the most suitable disposal option.

10.2 Hazardous waste assessment

10.2.1 Twelve samples of soils were selected for chemical testing during the recent 2014 investigation; an additional six soil samples were submitted for chemical testing during the 2015 investigation in for foreshore. The test results were assessed to classify the material using online software[23]. The results of this assessment are resented in Appendix H.

10.2.2 Five samples were classified as hazardous waste and these are: TH15 (1.75mbgl), TH13 P5 (0.5mbgl), TH13 P2 (1.1mbgl), TH13 (0.3mbgl) and FS3 (0mbgl). These samples exceeded hazardous waste thresholds for the following substances: TPH (C6 to C40) Petroleum Group (TH15 @ 1.75m, TH13 @ 0.5m, TH13 @ 1.1m), benzo[a]anthracene (TH13 @ 0.5m) and lead (TH13 @ 0.3m, FS3 @ 0m).

10.2.3 Sample TH15 @ 1.75m, was initially considered as potentially hazardous based but this classification but has been reclassified to non-hazardous due to the low proportion of benzo(a)pyrene relative to the total petroleum hydrocarbon concentrations (the EA's methodology for unknown oily waste based on the guidance outlined in the WM2 document).

10.2.4 It should be noted that WM2 will be replaced by WM3 in June 2015 and waste classification after that date may be different than that described above. For instance one result from the foreshore reported 1000mg/kg lead (FS1 at 0m). While currently not classed as hazardous waste, the current consultation document on WM3 suggests that the threshold for lead will reduce to 0.1% (1000mg/kg).

[22] Hazardous Waste, Interpretation of the definition and classification of hazardous waste (second edition, version2.2)

[23] www.hazwasteonline.com [accessed 15/12/14]

10.2.5 Soil chemical testing undertaken during the ground investigations has been assessed to determine the classification of this material.

10.2.6 The results of the Structural Soils 2011 chemical testing were below hazardous waste assessment levels except for one sample BA4504b at 0.5mbgl (due to copper and lead concentrations). The potentially hazardous properties of the Made Ground material resulting from these compounds can be found in Appendix H.

10.2.7 Concrete hardstanding was not tested during the latest investigation. It is likely that the concrete will be classified as inert waste, however, if there are hydrocarbons present on the surface this will require assessment.

10.3 Waste acceptance testing

10.3.1 Waste acceptance criteria (WAC) testing was undertaken as part of the recent 2014 and 2015 investigations and a limited number of tests were undertaken during the Structural Soils and FES investigations in 2011 and 2013 respectively. Material requiring disposal at hazardous or inert waste landfill sites must be tested for WAC and comply with the criteria for these landfills. The results of this testing are described below.

10.3.2 Additional WAC testing will need to be undertaken by the Contractor prior to disposal, at a frequency agreed with the landfill operator. The results of the above testing in conjunction with the additional WAC testing should be reviewed in conjunction with the hazardous waste assessment to provide an indication of whether or not such materials may be acceptable as inert waste.

SSL (2011)

10.3.3 WAC testing was carried out on three on-site samples (two Made Ground and one Alluvium). Results indicate that the two Made Ground samples would be classified as non-hazardous whilst the Alluvium sample would be classified as inert (although some sites may not accept alluvium if it appears organic).

FES (2013)

10.3.4 Two samples analysed for WAC purposes, from BHSA6242 at 2.5mbgl and BHSA6245 at 2.0mbgl, indicate that waste would be non-hazardous. The sample taken from BHSA6242 reported a TPH (C10-C40) result of 850mg/kg in comparison to the inert WAC of 500mg/kg.

2014 Investigation

10.3.5 Twelve samples of soil were selected for WAC assessment. The results of the WAC analysis are presented in Appendix D. Five of the samples were suitable for disposal at a landfill designed for accepting inert waste and the remaining samples would be acceptable at non-hazardous waste landfill. However three samples (all from TH13) did not meet the criteria for disposal at these landfills based on the waste classification testing (see above) and would therefore require disposal at hazardous landfill.

2015 Investigation

10.3.6 Six samples of soil were selected for WAC assessment. The results of the WAC analysus are presented in Appendix D. Five of the six samples were suitable for disposal at a landfill designed for accepting inert waste. One of the samples (FS3 @ 0.0mbgl) did not meet the criteria for disposal at these landfills based on the waste classification testing and would therefore require disposal at a hazardous landfill.

11 Considerations for adjacent plots

11.1.1 Considering the limited nature and extent of the advanced works, and the mitigation already described in this assessment, they will not affect adjacent plots.

12 High-level remediation

12.1 Remediation options appraisal

12.1.1 The CSM and risk assessments have considered the risks to receptors during the construction phase and post construction (following completion of the advanced works).

12.1.2 The risk assessments have demonstrated that risks to receptors following completion of the works are very low to negligible and do not require additional mitigation measures.

12.1.3 However, there remains a residual risk to receptors during the construction works if construction activities are not properly controlled. The following plausible pollutant linkages require mitigation during the construction works:

a. Exposure of construction workers to Made Ground soils (in ground and stockpiles) via dermal contact, inhalation of soil dust and vapours, and ingestion of soil;

b. Exposure of construction workers to shallow groundwater via dermal contact, inhalation of vapours, and ingestion;

c. Exposure of users of neighbouring sites to dusts originating from Made Ground stockpiles or when the ground is disturbed via inhalation of soil dust;

d. Flow of run off from temporary stockpiles into surface waters; and

e. Distrubance of contamination during scour protection works.

12.2 Remediation strategy

12.2.1 The only residual PPL after generic assessment are those during the construction phase. Consequently this remediation strategy focuses on the risks to construction workers, users of adjacent sites and controlled waters resulting from construction activities.

12.2.2 The following construction measures are required to mitigate these risks:

a. Site briefings, health and safety measures, enhanced hygiene and PPE;

b. Materials management;

c. Stockpile management and pollution prevention;

d. Dust suppression and monitoring;

e. Procedures for unexpected contamination.

12.2.3 Relevant information should be collected during the site works to confirm these measures have been implemented and that should be reported in a

verification report. Further details of the contents of the verification report are provided in Appendix I.

12.3 Implementation

Responsible parties

12.3.1 The Contractor must undertake the works in accordance with the requirements of the Order. This includes the CoCP Part A which requires production of a Construction Environmental Management Plan (CEMP). This should include details of how the recommendations of this Site Specific Remediation Strategy will be implemented.

12.3.2 In addition, further consultation with regulators (and formal approval where required by the Order) will be undertaken in relation to the following:

a. London Borough of Wandsworth (LBW) are the approval body in relation to Schedule 3 requirement DRMST3. This SSRS addresses DRMST3 (1), LBW would approve any further elements under DRMST (3), (4) and (5). ;

b. The Environment Agency would be consulted on the aspects referred to in para 12.3.2 a and would also be contacted in relation to:

   i Discharge consent to surface water (if required),

   ii Waste management permits (if required) although it is considered unlikely a permit would be required for the works being assessed in this report;

   iii If the site produces hazardous waste (which is likely based on some of the soils results) it will be necessary to register the site with the EA as a producer of hazardous waste before the waste leaves the site;

   iv Any dewatering of the upper aquifer required would be undertaken in accordance with the Groundwater Environment Management – Dewatering and Monitoring Strategy as per requirement PW13 of the Order. Any alterations to this strategy would need to be submitted to and agreed by the EA.

12.3.3 In addition, the following may also be required.

a. Materials Management Plan (MMP) although it is considered unlikely a MMP would be required for the works being assessed in this report which will principally require removal of wastes from site;

b. If asbestos is identified then there may be a requirement to pre-notify the Health and Safety Executive (HSE) and some works may require a licensed contractor. Works may be licensed, non-licensed, or notifiable non-licensed works. See CoCP Part A, Section 9 for further detail.

c. Waste treatment facilities shall be consulted where soil treatment is required;

d. Landfill sites shall be consulted if disposal of excavated soil is proposed;

e. Chemical laboratories where testing, for example for waste acceptance, is required.

12.3.4 Where possible the Contractor and designers should plan the construction works to reduce the risks associated with disturbing Made Ground soils.

Site Health and Safety and PPE

12.3.5 The Contractor shall be responsible for implementing appropriate health and safety procedures during the works to reduce potential exposure to contamination in accordance with the principle of 'as low as reasonably practicable' (ALARP).

12.3.6 This should include appropriate staff briefings to explain the risks associated with the known contaminants on site, and those which may be encountered (such as lead, hydrocarbons and the potential for asbestos – see below).

12.3.7 The site investigations undertaken included screening for asbestos containing materials. The samples tested did not detect asbestos. However, there remains potential for ACM or fibres to exist in soils not tested or investigated given the brownfield history and historical building demolition.

12.3.8 An occupational risk assessment should be undertaken by a competent assessor (asbestos specialist) in accordance with CAR 2012[24] and the associated code of practice to determine the likely exposure resulting from the works and the level of protection and management required by CAR 2012, this will also identify if the works with asbestos will be licensed, notifiable non-licensed work or non-licensed work and what notifications and health surveillance is required.

12.3.9 Although free phase hydrocarbon (oils) were not generally encountered in significant amounts during the investigation works, evidence of hydrocarbons was identified including some sheens and odours around TH13 and TH15. Consequently there is potential for encountering this type of contamination during excavation.

12.3.10 Sufficient hygiene units and personal protective equipment (PPE) shall be provided for the works. Suitably competent personnel should advise on and supervise the works and all staff should be briefed on the working methods. PPE shall be protective of the contaminants identified on site. This shall include provision of PPE for asbestos fibres as specified by an asbestos specialist.

Materials management

12.3.11 No soil material will be imported to site during the advanced works.

[24] HSE, 2012, The Control of Asbestos Regulations 2012

12.3.12 Relatively small volumes of material will be excavated and this material will require transport off-site. The Contractor is responsible for the off site disposal of all waste generated from the works and ensuring this is disposed of at a suitable facility. Section 10 provides an indication of the waste classification, however it will be the responsibility of the Contractor to classify the material intended for disposal at landfill.

12.3.13 Should it be agreed that surplus materials can be used in later phases of the works the Contractor will be required to provide a Management Plan and risk assessments as appropriate.

12.3.14 In accordance with Section 10 of the Code of Construction Practice (CoCP)[25] a Site Waste Management Plan (SWMP) will be prodcued. This will keep an accurate record of all waste soils leaving the Site will be maintained along with the basic characterisation data required to satisfy the waste regulations and other regulations including the Duty of Care.

Stockpile management

12.3.15 The Contractor shall manage stockpile management in accordance with Environment Agency pollution prevention guidance (PPG)[26]. This shall include measures to prevent the spread of material, liquid and potential cross contamination.

12.3.16 A separate quarantine area for stockpiling of excavated unexpected contamination (as described in the section below) will be provided.

12.3.17 The measures shall include bunding or similar which will prevent the flow of run-off from entering the nearby water courses (Bell Lane Creek and River Wandle). Where possible the stockpiles shall be located away from the surface water courses. Details for the disposal of water collected in the bund are described later in this section.

Dust suppression and monitoring

12.3.18 There is a potential risk for inhalation and/or ingestion of fugitive dust generated as part of the construction work. In accordance with Section 7 of the CoCP the Contractor will be responsible for developing an Air Quality Management Plan (AQMP) which will include;

a. an inventory and timetable of activities which may give rise to emissions or dust;

b. alert levels;

c. alert system to be used (including notification process);

d. details of control measures;

[25] TTT, March 2014, Application for Development Consent WW010001. Code of Construction Practice Part A: General Requirements

[26] https://www.gov.uk/government/collections/pollution-prevention-guidance-ppg

e. details of dust monitoring arrangements, including the location of sensitive receptors, monitoring locations and monitoring equipment to be used;and

f. details of the air quality reporting requirements.

12.3.19 As a minimum the AQMP will include controls to minimise dust emissions. Two levels of control for dust impacts are required using tecniques in line with best practice guidance/supplementary planning guidance and the Building research Estabblishment's Publication (BRE)[27]. Regulatory and Client approval of the methods will be required prior to commencing work on site.

12.3.20 If asbestos is identified then air monitoring may be required as well as enhanced control measures during the works to confirm the absence of respirable fibres above the CAR 2012[24] action levels. If the works will take place adjacent to occupied parts of the site a lower detection limit (than used for occupational monitoring), i.e. 0.00001 f/ml, for air monitoring at the boundary, may be appropriate (this is a recommendation from CIRIA C733[28]).

Unexpected contamination

12.3.21 If previously unidentified areas of potential contamination (such as hydrocarbon impacted soils or additional ACM) are encountered the following steps should be taken:

a. Soil should either be sampled in situ in the ground (and left undisturbed while the samples are tested and the results interpreted) or be excavated and stockpiled separately in an appropriate manner (i.e. bunded and covered stockpile in a designated area separate from other stockpiles).

b. On-site testing may be advantageous in providing quicker results if undertaken by qualified and experienced personnel.

c. Measures should be taken to restrict dust and surface water run-off. On receipt of the laboratory results, soils should either be transported off-site to a suitable permitted landfill or a soil treatment facility.

d. If the intention is to leave the soil in situ the Contractor shall complete appropriate human and health and controlled waters risk assessments to demonstrate it is safe to do so. The risk assessments shall be approved by the Client and LBWC CLO. The Contractor shall discuss the options of removing the material with the Client as removal may be desirable to remove constraints for future construction phases.

e. The location of the contamination which is left in situ shall be logged for use in subsequent phases of the shaft construction. The location of the contamination, laboratory test results and risk assessment shall be documented in the verification report.

[27] BRE Report , 2003, Controlling particles, vapour and noise pollution from construction sites, Part 1- 5

[28] CIRIA, 2014, Asbestos in soil and made ground: a guide to understanding and managing risks

f. Sampling should be undertaken by suitably qualified and experienced personnel aware of the remediation design objectives. The laboratory chemical analysis should be undertaken in accordance with MCERTS validated methods. On-site testing may be used to supplement the laboratory testing and a strategy for undertaking such work should be agreed in advance.

g. If the soil remains in situ, or is re-used on site then soil criteria will be developed based on the risk assessments described in point (d) above. Samples of the soils will be tested for the contaminants of concern and validated as meeting the soil criteria.

h. LBWC contaminated land officer should be informed if significant unexpected contamination is encountered.

12.3.22 Buried tanks have not been identified as part of the investigations in Keltbray Yard. Mott MacDonald conducted a search of London Fire Brigade records which revealed a number of tanks in the Frogmore Depot which have been foam infilled[2].

12.3.23 There remains a low risk that other tanks are present on site in the Keltbray Yard site. Should an underground tank be encountered, operations should cease in the area and the CLO should be contacted to discuss appropriate removal and verification measures. The Contractor should submit proposals for dealing with the buried tank and any associated contamination to both the CLO and the Client for approval prior to commencement. Naked flame certificates will be required prior to removal.

Water disposal

12.3.24 It is expected that a limited volume of water will collect in the bunding. Some limited pumping may be required during the excavation of the residual soil between the new ad old river wall. The site investigation identified water at a level of approximately 1.8mbgl and excavation of this soil down to 3m is required. Depending on groundwater levels during the advanced works, and the potential for leakage of the old wall during high tide, this may require abstraction during the excavation. The new river wall will prevent seepage of groundwater (from the south) into the excavation.

12.3.25 Both the bund collection water and the excavation groundwater may contain concentrations of hydrocarbons and other contaminants at levels that are not suitable for discharge to surface waters without further treatment. Unless otherwise agreed with the EA, the Contractor shall dispose of the water at an appropriate licensed water treatment facility, which may include foul sewer if agreed with Thames Water. Alternatively this may be discharged to surface water a via mobile treatment plant with EA permit required.

12.3.26 Prior to abstraction and disposal of this water, the Contractor shall sample the collected water and test for the parameters defined within the discharge permit (obtained from the EA or Thames Water). The water may only be discharged via the permitted route if the volumes and

parameters (contaminant and solids), fall within those defined in the permit.

Monitroing of water surface water quality

12.3.27 In general, the sampling from the forershore has not indicated any significant contamination (such as gross contamination or NAPL). Elevated concentrations of lead were identified in the shallow samples (at the top of the foreshore soils (0m bgl). Depper samples all reported low concentrations in soils. The leachable concentrations of soils from the foreshore were generally very low and when considered for the environmental setting (likely form of contaminant and the hardenss of the surface water) then the results were very low. The recent monitroing of surface water did not indicate any significant contamination in the area of the proposed works. It would be prudent to undertake some further monitoring of surface water during and after the works to provide additional lines of evidence to demonstrate the foreshore works, in particular, have not impacted water quality.

Verification plan

12.3.28 In line with Section 9 of the CoCP, on completion of any remedial works a record will be kept of the works carried out to comply with the remedial strategy. The contractor will issue a verification report to the employer, EA and the local authority.

12.3.29 The verification plan details the process for gathering data in order to demonstrate that remediation activities (risk management measures) have meet the remediation objectives set. The information gathered as a result of the requirements set out within the verification plan are then used to produce a verification report once the remediation is complete.

12.3.30 Details of the verification plan are presented in Appendix I.

Long term monitoring

12.3.31 Long term monitoring is not required following completion of the advanced works.

I.1.1 The Dormay Street Advanced Works are located within the Keltbray Yard area of the Dormay Street TTT site in the London Borough (LB) of Wandsworth.

I.1.2 These advanced works include the following elements:

a. Installation of a new river retaining wall;

b. Removal of the existing river retaining wall and construction of an ecological terrace;

c. Removal of a weigh-station and temporary reinstatement;

d. Scour protection to the foreshore; and

e. Demolition of existing site buildings.

I.1.3 Several phases of work have been completed at the site including desk study, several phases of ground investigation, contamination assessments for the wider site and risk assessments presented within the SSRS report.

I.1.4 The risk assessments have demonstrated that risks to receptors following completion of the works are very low to negligible and do not require additional mitigation measures.

I.1.5 The only residual PPL after generic assessment are those during the construction phase. Consequently this remediation strategy focuses on the risks to construction workers, users of adjacent sites and controlled waters resulting from construction activities.

I.1.6 Site investigations identified concentrations of lead and benzo(a)pyrene in soils above commercial screening values and there is a potential for asbestos. Leachable concentrations of the Made Ground soils exceeded environmental standards and run-off from stockpiles of this poses a low risk to the adjacent water courses.

I.1.7 Shallow groundwater at the sight was observed with a hydrocarbon sheen and odour, particularly near to the existing river wall. In addition soil concentrations for hydrocarbons suggest a possibility of some free phase hydrocarbon contamination. Consequently there is a low risk posed top construction workers by hydrocarbons.

I.1.8 The objectives of the verification plan are to document the evidence that the construction activities and mitigation measures outlined in the SSRS have been implemented during the construction works.

I.1.9 The following site specific reports and data have been reviewed when preparing this assessment:

a. Mott MacDonald, November 2013, Thames Tideway Tunnels: Dormay Street, Wandsworth, Phase 1 Contamination Risk Assessment Report (321835/EVT/EES/01/D);

b. Mott MacDonald, August 2014, Thames Tideway Tunnels: Dormay Street, Wandsworth, Phase 2 Contamination Assessment (321835FF02/EVT/EES/DRM01/A);

c. Thames Water, September 2013, Geotechnical Desk Study: PWH7X – Dormay Street (100-RG-GEO-PWH7X-000003);

d. Thames Water, October 2013, Land Condition Report – Dormay Street (150-RG-ENV-PWH2X-000001);

e. Thames Water, July 2013, Thames Tideway Tunnel Ground Investigation Report PWH7X – Dormay Street (100-RG-GEO-PWH7X-000006_AC);

f. Fugro Engineering Services, December 2013, Thames Tideway Tunnel Dormay Street River Wall Investigation - Factual Report On Ground Investigation (302-RG-GEO-LC222-00004);

g. Structural Soils, May 2011, Interpretive Report on Ground Investigation at Dormay Street Wandsworth (Report 725401);

h. Ove Arup and Partners Ltd, December 2014, Site Specific Remediation Strategy Dormay Street Site Advanced Works.

I.2.1 The Client is Thames Water Utilities PLC.

I.2.2 At the time of writing the Contractor responsible for implementing the construction mitigation measures has not been defined.

I.3.1 The following construction measures are required to mitigate risks from these contaminants:

a. Site briefings, health and safety measures, enhanced hygiene and PPE;

b. Materials management;

c. Stockpile management and pollution prevention measures;

d. Dust suppression and monitoring;

e. Surface water monitoring during works

f. Procedures for unexpected contamination.

I.4.1 A Verification Report is required and shall be prepared by the Contractor and submitted to the Client and the LBWC CLO following completion of the works. The following evidence shall be collected by the Contractor during the construction works and reported in the Verification Report:

I.5.1 The Contractor shall provide evidence of conformance to requirements of licensed activities including discharge consents, abstraction licences, waste licences etc.

I.6.1 The Contractor shall appoint an asbestos specialist to assess the risks to Construction workers and users of neighbouring sites from asbestos. The assessment shall be completed in accordance with CAR 2012[23] and the associated code of practice.

I.6.2 The Contractor shall provide the assessment and mitigation measures recommended by the asbestos specialist within the verification report. The Contractor shall provide documentation and evidence that the mitigation measures have been implemented, including air quality

monitoring certificates, PPE provided to staff, damping down of stockpiles and excavations, safe disposal of PPE and asbestos containing wastes and any other recommendations.

I.7.1 The Contractor shall prepare a method for briefing staff of the risks associated with the known contaminants on site. This may be in the form of an induction presentation, toolbox talk or information leaflet. The Contractor shall keep a record of the staff attending the briefings.

I.7.2 The Contractor shall include the findings of the asbestos specialist in the Verification Report and demonstrate that the recommendations have been implemented.

I.8.1 An accurate record of all waste soils leaving the Site will be maintained along with the basic characterisation data required to satisfy the waste regulations and other regulations including the Duty of Care.

I.9.1 The Contractor shall describe the methods for stockpile management and records and photographs showing the positions of the stockpiles and any mitigation measures such as bunding, and damping down of the stockpiles.

I.10.1 The Contractor shall include the approved air quality management plan. The Contractor shall provide evidence that the dust control measures were implemented, including photographic evidence and air quality monitoring certificates, including for asbestos, if recommended by the asbestos specialist.

I.10.2 The Contractor shall document any complaints and the measures implemented to reduce the impacts of construction works which may be the cause of the complaints.

I.11.1 If previously unidentified areas of potential contamination (such as hydrocarbon impacted soils or additional ACM) are encountered the Contractor shall document the procedures implemented to mitigate the risks to the environment and site workers. This should follow the procedures outlined in Section 11 of the SSRS.

I.11.2 Records shall include correspondence with regulators and the Client team, results of laboratory testing, details of the location of the contamination and where the material was transported to (if removed).

A limited volume of water is likely to require disposal (stockpile bund collection water and in the excavated zone between the two walls). The Contractor shall provide details of the permit for the disposal of this water. The Contractor shall provide records demonstrating the water meets the requirements of the permit, including volumes, solid content, contaminant concentrations and others specified in the permit.