Thames Tideway Tunnel
Thames Water Utilities Limited

Thames Water

Development Consent Order

Application Reference Number: WWO10001

Documents for Certification
September 2014

We, Lindsay Speed and Sarah Fairbrother hereby certify that this is a true copy of the environmental statement referred to in Article 61 (1) (f) of the Thames Water Utilities Limited (Thames Tideway Tunnel) Order 2014.

Lindsay Speed   Sarah Fairbrother

September 2014

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

Thames Tideway Tunnel
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Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.16**

Volume 16: Albert Embankment Foreshore site assessment

APFP Regulations 2009: Regulation **5(2)(a)**

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Environmental Statement

Volume 16: Albert Embankment Foreshore site assessment

Errata

Section	Paragraph No.	Page No.	Errata / Clarification
Section 14 Water resources – surface water	14.5.16	15	Incorrect reference to Chelsea Bridge. Text should read “The temporary cofferdam at the Albert embankment Foreshore site may interact with Vauxhall Bridge to cause an area of slack ‘dead’ water between them.”

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Section 1: Introduction

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1 Introduction

1.1.1 This volume of the *Environmental Statement* of the Thames Tideway Tunnel project presents the results of the environmental impact assessment (EIA) of the proposed development at the Albert Embankment Foreshore site.

1.1.2 The proposal at this site is to intercept the existing combined sewer overflows from the Clapham Storm Relief Sewer and Brixton Storm Relief Sewer. The Clapham Storm Relief Sewer currently discharges approximately six times in a typical year, with a total volume discharge of approximately 13,000m^3 in a typical year. The Brixton Storm Relief Sewer currently discharges approximately 29 times in a typical year, with a total volume discharge of approximately 265,000m^3 in a typical year.

1.1.3 The site and environmental context are described in Section 2. The proposed development, comprising both the construction and operational phases, is described in Section 3. Those elements of the proposal for which development consent is sought are described followed by a description of the assumptions applied to the assessment of construction and operational effects. Finally in Section 3.6, the main alternatives which have been considered for this site are presented.

1.1.4 Sections 4 to 15 present the environmental assessments for each topic, which are presented alphabetically. The order of these topics and the structure of each assessment remains the same across different sites.

1.1.5 Figures and appendices for this site are appended separately (see Vol 16 Albert Embankment Foreshore figures volume and Vol 16 Albert Embankment Foreshore appendices). In addition, there is a separate glossary and abbreviations document which explains technical terms used within this assessment.

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Application for Development Consent

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Environmental Statement

Doc Ref: **6.2.16**

Volume 16: Albert Embankment Foreshore site assessment

Section 2: Site context

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2 Site context

2.1.1 The proposed development site is located within the London Borough (LB) of Lambeth. It comprises the River Thames foreshore under, and on both sides of the Grade II* listed Vauxhall Bridge, and extends approximately 250m north. The site includes Lack's Dock access and slipway which is currently used by the commercial tour company, 'London Duck Tours', as an entry and exit point to the River Thames for amphibious vehicle tours. Within the site, north of Vauxhall Bridge, is Brixton Storm Relief combined sewer overflow (CSO) and to the south of Vauxhall Bridge is Clapham Storm Relief CSO, both of which discharge into the River Thames at this location. The site extent is defined by the limits of land to be acquired or used (LLAU) and covers an area of approximately 3.1 hectares. The site context and location is shown in Vol 16 Figure 2.1.1 (see separate volume of figures).

2.1.2 The site is bounded by the River Thames to the north, south and west. Vauxhall Cross and two high rise office buildings (Camelford House and Tintagel House) plus the St George Wharf mixed use development (the closest building in the development being Bridge House) are located along the eastern boundary of the site. Beyond these buildings is the Albert Embankment (A3036). High-rise residential properties are located at Peninsula Heights to the northeast of the site. Vauxhall Bridge crosses over the southern section of the site. Vol 16 Plate 2.1.1 provides an aerial view of the site.

Vol 16 Plate 2.1.1 Albert Embankment Foreshore – aerial photograph

2.1.3 The general pattern of existing land uses within and around the site is shown in Vol 16 Figure 2.1.2 (see separate volume of figures).

2.1.4 Two options for site access during the construction phase, both from Albert Embankment (A3036), are included within the site and are in the application for development consent ('the application'). The Secretary of State will be asked to determine which option should be provided in any decision to grant development consent for the project. Option A is via Lack's Dock (as shown in Vol 16 Plate 2.1.2); Option B involves the construction of a temporary road access between Camelford House and Tintagel House for the majority of construction traffic with occasional access for large construction plant via Lack's Dock.

2.1.5 The closest railway station is Vauxhall Station (National Rail and underground services) located approximately 200m walking distance to the southeast of the site. There are no existing wharves or jetty facilities within the site; although there is a new passenger pier at St George Wharf to the south of Vauxhall Bridge. The Thames Path National Trail runs along the embankment, partially within the site.

Vol 16 Plate 2.1.2 Albert Embankment Foreshore – Lack's Dock

2.1.6 There are a number of receptors in close proximity to the site and these include residential, educational, commercial and recreational receptors as follows (approximate closest distance to the proposed main site hoarding is given):

a. residential:

   i Bridge House - adjacent to the southwest of the hoarding

b. educational:

   i Chelsea College of Art and Design – 225m northwest of the hoarding across the River Thames

c. commercial:

   i Vauxhall Cross and Camelford House offices - adjacent to the east of the hoarding

   ii Tintagel House offices - adjacent to the northeast of the hoarding

d. recreational:

   i River Thames – within cofferdam area

   ii Thames Path National Trail – adjacent to and within the site hoarding

2.1.7 Environmental designations for the site and immediate surrounds are shown in Vol 16 Figure 2.1.3 (see separate volume of figures).

2.1.8 The northern part of the LB of Lambeth, which includes the Albert Embankment Foreshore site, has been designated as an air quality management area (AQMA) for nitrogen dioxide (NO_2).

2.1.9 There are no designated statutory nature conservation sites within the local area although the foreshore areas fall within the River Thames and Tidal Tributaries Site of Importance for Nature Conservation (SINC) (Metropolitan level).

2.1.10 The southern part of the site is located beneath the Grade II* listed Vauxhall Bridge. Four Grade II listed public benches are located near the northern end of the site (immediately north of Peninsula Heights). The river wall in this location and the sturgeon lamps which sit on the wall, are also listed.

2.1.11 The northern part of the site lies within the Albert Embankment Conservation Area, which is a designated Archaeological Priority Area (APA). The northern part of the site also lies within the North Lambeth and Lambeth Palace APA.

2.1.12 There are no tree preservation orders (TPOs) in effect within or adjacent to the site. Trees have been planted within and around the site for ornamental purposes. These trees do not have any specific ecological designations and are not listed on the local Biodiversity Action Plan (BAP).

2.1.13 The site has not been subject to major contaminative history as it mostly comprises the River Thames foreshore; therefore the site has low potential for contamination. Local geology comprises superficial deposits and made ground, London clay, Lambeth group and Thanet sand.

2.1.14 The site is located within the Flood Zone 3 of the River Thames and the current terrestrial areas are defended.

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Volume 16: Albert Embankment Foreshore site assessment

Section 3: Proposed development

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3 Proposed development

3.1 Overview

3.1.1 The Albert Embankment Foreshore site would function as a CSO interception site. Two cofferdam areas would be constructed one either side of Lack's Dock: the one to the north to provide a construction platform to build a CSO drop shaft and an air treatment chamber and the one to the south to construct a combined interception chamber and connection culvert to the drop shaft under the foreshore and connection culverts to the Clapham and Brixton Storm Relief Sewers. The shaft would be connected to the main tunnel by a short connection tunnel under the river.

3.1.2 The Albert Embankment Foreshore assessments consider the two access options presented at para. 2.1.4. For those topics where a change in the location of the site access could present a change to the assessment findings, Option A is assessed first, followed by Option B. The results of the assessment of both options are presented in the assessment summary tables unless stated otherwise.

3.1.3 The geographic extent of the proposals for which development consent is sought, is defined by the limits of land to be acquired or used (LLAU).

3.1.4 This section of the assessment provides a description of the proposed development. The defined project for which consent is sought is described in Section 3.2. In Section 3.3, assumptions are presented on how the development at this site is likely to be constructed and includes the assumed programme and typical construction activities. Section 3.4 sets out operational assumptions in terms of operational structures and the typical maintenance regime. These construction and operational assumptions underpin the assessment.

3.1.5 Other developments may become operational in advance of or during the Thames Tideway Tunnel project thereby changing the baseline conditions. In order to undertake an accurate assessment it is necessary to compare the predicted situation with the Thames Tideway Tunnel project in place with this future baseline conditions ('base case') (rather than comparing it with the current conditions). In addition, other developments may be under construction at the same time as construction or operation of the Thames Tideway Tunnel project and this could lead to cumulative effects. Information regarding schemes included in the base case and in the cumulative assessment is summarised in Section 3.5 with details included in Vol 16 Appendix N. The methodology for identifying these schemes is explained in Volume 2 Section 3.8. Finally, Section 3.6 describes any on-site alternatives considered.

3.2 Defined project

3.2.1 This section identifies the proposals for which consent is sought and so those which can be regarded, subject to approval, as being “certain” or nearly so (eg, indicative locations).

3.2.2 Vol 16 Table 3.2.1 below sets out documents and plans for which consent is sought and which have been assessed.

Vol 16 Table 3.2.1 Albert Embankment Foreshore – plans and documents defining the proposed development

Document /Plan Title	Status	Location
Proposed schedule of works	For approval	Schedule 1 of *The Draft Thames Water Utilities Limited (Thames Tideway Tunnel) Development Consent Order 201[ ] (Draft DCO)* (and extracts below)
Site works parameter plan	For approval	Vol 16 Albert Embankment Foreshore figures – Section 1
Demolition and site clearance plans	For approval	Vol 16 Albert Embankment Foreshore figures – Section 1
Access plan	For approval	Vol 16 Albert Embankment Foreshore figures – Section 1
Proposed landscape plan – interception structure	Indicative only – but scale of above ground structures are illustrative	Vol 16 Albert Embankment Foreshore figures – Section 1
Proposed landscape plan – shaft structure	Indicative only – but scale of above ground structures are illustrative	Vol 16 Albert Embankment Foreshore figures – Section 1
Proposed listed structure interface plan – interception structure	Indicative only	Vol 16 Albert Embankment Foreshore figures – Section 1
Design intent plans for kiosk and river wall	Indicative only	Vol 16 Albert Embankment

Document /Plan Title	Status	Location
		Foreshore figures – Section 1
Design principles: Generic principles	For approval	*Design Principles* report Section 3 (see Vol 1 Appendix B)
Design principles: Site specific principles (Albert Embankment Foreshore)	For approval	*Design Principles* report Section 4.13 (see Vol 1 Appendix B)
Code of Construction Practice Part A: General requirements	For approval	*CoCP Part A* (see Vol 1 Appendix A)
Code of Construction Practice Part B – Site-specific requirements Albert Embankment Foreshore	For approval	*CoCP Part B Albert Embankment Foreshore* (see Vol 1 Appendix A)

Description of the proposed works

3.2.1 Schedule 1 to the *Draft DCO* describes the proposed works for which development consent is sought. The schedule describes the main tunnel, connection tunnels and also the works which would be required at each of the proposed sites within the project. This includes the works comprising the NSIP and associated development (which are described in Part 1 of Schedule 1) and ancillary works (which are described in Part 2 of Schedule 1).

3.2.2 The following sections provide a description of the proposed works at this site under three headings: Nationally significant infrastructure project, Associated development and Ancillary works. The description of the proposed works has been taken from Schedule 1 to the *Draft DCO* and the codes given for the works are those given within that schedule.

3.2.3 In accordance with the *Draft DCO*, all distances, directions and lengths referred to are approximate. All distances for scheduled linear works referred to are measured along the centre line of the limit of deviation for that work. Internal diameters for tunnels and shafts are the approximate internal dimensions after the construction of a tunnel lining. Unless otherwise stated, depths are specified to invert level and are measured from the proposed final ground level.

Nationally significant infrastructure project

3.2.4 The proposed structures and works required at this site which comprise the nationally significant infrastructure project are as follows:

a. **Work No. 15a**: Albert Embankment Foreshore CSO drop shaft – A shaft with an internal diameter of 16 metres and a depth (to invert level) of 48 metres

b. **Work No. 15b**: Clapham / Brixton connection tunnel – A tunnel between Albert Embankment Foreshore CSO drop shaft (Work No. 15a) and the main tunnel (east central) (Work No. 1c)

Associated development

3.2.5 The proposed structures and works required at this site which comprise associated development are as follows:

a. **Work No. 15c**: Albert Embankment Foreshore associated development - Works to intercept and divert flow from the Brixton Storm Relief CSO and the Clapham Storm Relief CSO to the Albert Embankment Foreshore CSO drop shaft (Work No. 15a) and into the Clapham / Brixton connection tunnel (Work No. 15b) including the following above and below ground works:

- i partial demolition of existing river wall and construction of new river wall including connection to and alteration of the existing river wall to reclaim land and to enclose elements of Work No. 15c(vii), (ix) and (x) under and adjacent to the listed Vauxhall Bridge including protection of bridge abutment and arch, and scour protection works including new CSO outfall aprons, relocation of the existing Clapham Storm Relief CSO and Brixton Storm Relief CSO to form the new Effra CSO
- ii works for the protection of the existing slipway, and existing river wall within and to the north of Work No. 15(c)(i)
- iii partial demolition of existing river wall and construction of new river wall including connection to and alteration of the existing river wall to reclaim land and to enclose Work No. 15a and elements of Work No. 15c(vii), (ix) and (x) to the north of Lacks Dock slipway and scour protection works
- iv removal of existing CSO aprons and overflow structures (including timber dolphins and posts) in the foreshore
- v dredging and construction of cofferdam (relating to Works No. 15c(i)) including the placement of fill material, connection to the existing river wall and construction of campsheds adjacent to cofferdam and temporary ramp from foreshore
- vi dredging and construction of cofferdam (relating to Works No. 15c(iii)) including the placement of fill material, connection to the existing river wall and construction of campsheds adjacent to cofferdam
- vii construction of an interception chamber, hydraulic structures, chambers with access covers and other structures including culverts, pipes and ducts to modify, connect, control, ventilate, de-aerate, and intercept flow
- viii works to the listed Vauxhall Bridge abutment and pier(s) in connection with Work Nos. 15c(i), (v) and (vii)

ix construction of structures for air management plant and equipment including filters and ventilation columns and associated below ground ducts and chambers

x construction of electrical and control kiosks and local control pillars

xi construction of pits, chambers, ducts and pipes for cables, hydraulic pipelines, utility connections, utility diversions and drainage

[and either Option A]

xii works to create construction access from Albert Embankment via the existing Lack's Dock (including demolition of existing concrete wall and planter on north side of Lack's Dock) and subsequent reinstatement

[or Option B]

xiii works to create a new construction access from Albert Embankment between Camelford House and Tintagel House (including demolition of steps and boundary walls, and modifications to ramp to basement car park to Camelford House) and subsequent reinstatement to original layout

xiv temporary relocation of existing vehicle control barrier and security kiosk at entrance to Lack's Dock from Albert Embankment and temporary provision of traffic control measures; [Option A only]

xv provision of permanent access from Albert Embankment via Lack's Dock

3.2.6 Both of these options are included in the application. The Secretary of State will be asked to confirm which option should be provided in any decision to grant development consent for the project. Only that option would be granted development consent. Pre-application consultation has been completed on both options. This *Environmental Statement* reports on the likely significant environmental effects of both options.

3.2.7 The maximum heights of above ground structures, which are for approval, and shown on the site works parameter plan are as follows:

a. Ventilation column(s) serving the shaft = 8m (with minimum 4.0m)

b. Ventilation column(s) serving the interception chamber = 6.0m

c. Electrical and control kiosks = 2.5m (with minimum 1.5m)

3.2.8 In addition, further works are required at this site that constitute associated development within the meaning of section 115(2) of the Planning Act 2008. These comprise:

a. establishment of temporary construction areas at each works site to include, as necessary, site hoardings/means of enclosure, demolition (including of existing walls, fences, planters, and other buildings and other above and below ground structures), provision of services, including telecommunications, water and power supplies (including substations) including means of enclosure, and ground preparation works including land remediation and groundwater de-watering

b. provision of welfare/office accommodation, workshops and stores, storage and handling areas, facilities for and equipment for processing of excavated materials, treatment enclosures and other temporary facilities, plant, cranes, machinery, temporary bridges and accesses, and any other temporary works required

c. in connection with Work Nos. 5, 6, [8] , 11, 12, 13, 14, 15, 16, 17, 19, [23], 24 [and 26] the provision of temporary moorings (including dolphins) and other equipment and facilities for temporary use by barges, pontoons and other floating structures and apparatus (including as necessary piling for support of such structures) for use in construction of those works, and works for the strengthening of river walls and other flood protection defences

d. temporary removal of coach and car parking bays and creation of temporary replacement coach and car-parking as required and temporary footpath diversions

e. restoration of temporary construction areas, works to restore and make safe temporary work sites and work areas, including (as necessary) removal of hardstanding areas, temporary structures and other temporary works and works to re-establish original ground levels

f. works to trees

g. works to create temporary or permanent landscaping, including drainage and flood compensation, means of enclosure, and reinstatement / replacement of, or construction of, boundary walls and fences including gates

h. formation of construction vehicle accesses and provision of temporary gated or other site accesses and other works to streets

i. diversions (both temporary and permanent) of existing traffic and pedestrian access routes and subsequent reinstatement of existing routes, and works to create permissive rights of way

j. modifications of existing accesses, railings and pedestrian accesses

k. provision of construction traffic signage

l. relocation of existing bus stops and provision of temporary bus lay-bys

m. construction of new permanent moorings and piers, including access brows, bank seats, gangways and means of access

n. permanent and temporary works for the benefit or protection of land or structures affected by the authorised project (including protective works to buildings and other structures, and works for the monitoring of buildings and structures)

o. temporary landing places, moorings or other means of accommodating vessels in the construction and/or maintenance of the authorised project

p. provision of buoys, beacons, fenders and other navigational warning or ship impact protection works

q. such other works as may be necessary or expedient for the purposes of or in connection with the construction of the authorised project which do not give rise to any materially new or materially different environmental effects from those assessed in the Environmental Statement

3.2.9 The works defined by bullets d, k, l and m (in the list above) are not considered likely to be applicable to the works proposed at this site. Note that only the coach parking element of bullet d is not considered likely to apply.

Ancillary works

3.2.10 These works are not “development” as defined in section 32 of the Planning Act 2008, they do however form part of the Thames Tideway Tunnel project for which development consent will be sought and are included within Schedule 1 to the *Draft DCO*.

3.2.11 The following ancillary works are set out in Schedule 1 to the *Draft DCO*:

a. works within the existing sewers, chambers and culverts and other structures that comprise the existing sewerage network for the purposes of enabling the authorised project, including reconfiguring, modifying, altering, repairing, strengthening or reinstating the existing network

b. works within existing pumping stations including structural alterations to the interior fabric of the pumping station(s), works to reconfigure existing pipework, provision of new pipework, new penstock valves and associated equipment, modification of existing electrical, mechanical and control equipment, and installation or provision of new electrical, mechanical and control equipment

c. installation of electrical, mechanical and control equipment in other buildings and kiosks and modification to existing electrical, mechanical and control equipment in such buildings and kiosks

d. installation of pumps in chambers and buildings

e. works to trees and landscaping works not comprising development

f. works associated with monitoring of buildings and structures

g. provision of construction traffic signage

h. the relocation of boats/vessels

3.2.12 The works defined by bullets d and h are not considered likely to be applicable to the works proposed at this site.

Design principles

3.2.13 The design principles for the project have been developed with stakeholders and set the parameters that must be met in the final detailed design of the above-ground structures and spaces associated with the project. The principles apply only to the operational phase of the project (ie, the permanent structures).

3.2.14 The generic principles include principles for the integration of functional components and also principles for heritage, in-river structures, landscape, lighting and site drainage.

3.2.15 The design principles form an integral part of the project and are assumed to be implemented within the design of the operational development. Where individual principles are relevant to a particular topic, this is indicated within the relevant assessments.

3.2.16 The *Design Principles* report is provided in Vol 1 Appendix B.

Site features and landscaping

3.2.17 The proposed landscaping plans for the Albert Embankment Foreshore site are indicative and therefore have been assessed in the ES as shown with the exception of the location of the above-ground structures (including main tunnel shaft, electrical and control kiosks and ventilation columns) which could be located anywhere within the zones on the Site works parameter plan (see separate volume of figures – Section 1). The scale of the structures (including height) is however indicative and therefore has been assessed as such.

3.2.18 The other features on the proposed landscaping plans are indicative and have been assessed where necessary in the ES. Vegetated inter-tidal terraces are proposed around the interception foreshore structure. Tree planting is proposed on the shaft foreshore structure. In addition planting associated with the access routes would be required. If access Option A is chosen, replacement planting is proposed along Lack's Dock. If access Option B is chosen, two trees would be planted to replace trees that would be removed to facilitate construction of the access road.

Code of Construction Practice

3.2.19 All works would be undertaken in accordance with the *Code of Construction Practice (CoCP)*. The *CoCP* sets out a series of measures to protect the environment and limit disturbance from construction activities as far as reasonably practicable. These measures would be applied throughout the construction process at this site, and would be the responsibility of the contractor to implement. The *CoCP* comprises two parts, Part A and Part B. Part A presents measures which are applicable at all sites across the project and Part B defines measures which are only applicable at individual sites.

3.2.20 The *CoCP* forms an integral part of the project and all of the measures contained therein are assumed to be in place during the construction process described in Section 3.3 below. The measures are not described within Section 3.3 although further details on the measures within the *CoCP* Part B at Albert Embankment Foreshore are given within the relevant assessments.

3.3 Construction assumptions

3.3.1 This section describes the approach to construction which has been assumed for the purposes of the EIA. The construction programme, layouts and working methods are illustrative and do not form part of the project for which consent is sought. However, the maximum extent of the temporary works platform within the river is shown on the site works parameter plan (see Section 3.2 and separate volume of figures – Section 1) and is for approval.

3.3.2 Although the programme, layouts and working methods described are illustrative, they represent what is considered to be the likely approach, given the existing site constraints, the adjacent land uses and the construction requirements. This section describes only the main activities with the focus on those that are relevant for the assessment of environmental effects.

3.3.3 The assumed construction programme is described first, followed by typical construction activities.

3.3.4 It is also assumed that, where the appropriate powers do not form part of the Development Consent Order, further consents may be required before certain construction activities are progressed. These could include various consents issued by the Environment Agency (EA) (including flood defence consents, abstraction licenses and discharge consents) and the Port of London Authority (PLA) (including river works licenses) as appropriate.

Assumed construction programme and working hours

3.3.5 The main works at this site would be likely to commence in 2017 (Site Year 1) and would be completed in 2020 (Site Year 4). The infrastructure at the site would only become operational in 2023 when the Thames Tideway Tunnel project as a whole becomes operational.

3.3.6 Construction at this site is anticipated to take approximately three and a half years and would involve the following main works (with some overlaps):

a. Site Year 1 – Site set up (approximately 12 months)

b. Site Years 1 to 2 – Shaft construction (approximately ten months)

c. Site Year 2 – Tunnelling (approximately three months)

d. Site Years 2 to 3 – Construction of other structures (approximately 18 months)

e. Site Years 3 to 4 – Completion of works and site restoration, including installation of Mechanical, Electrical, Instrumentation, Control and Automation (MEICA) equipment (approximately ten months).

3.3.7 System-wide commissioning would take place following site restoration and is not included in the above programme.

3.3.8 This site would operate to the standard, extended and continuous working hours for various phases and activities as set out in the *CoCP* Part A and B (Section 4). Standard working hours would be applied to all of the above phases of construction work apart from elements of main tunnel shaft construction, tunneling and secondary lining as described below.

3.3.9 Extended working hours would be required at this site to allow for major concrete pours for the CSO drop shaft construction including diaphragm wall panels, base slab, roof slab and other large elements. It has been assumed that extended hours would be required for approximately twice a week during diaphragm walling for a total duration of approximately four months, and for once a month during other major concrete pours. The exact timing of any extended hours of working would be consulted on, and notified to the London Borough (LB) of Lambeth.

3.3.10 It has been assumed for assessment purposes that continuous hours would be required during construction and secondary lining of the connection tunnel for a duration of approximately three months. However, it is noted that there would be periods of activity within this phase where continuous 24 hour working would not be required.

3.3.11 During these periods only those activities directly connected with the task would be permitted within the varied hours.

Typical construction activities

3.3.12 Vol 16 Table 3.3.1 table identifies the construction phasing plans used for the assessment of construction effects. These plans have been prepared to illustrate possible site layouts for the principle construction phases and relevant activities.

Vol 16 Table 3.3.1 Albert Embankment Foreshore – construction phase plans

Document/Plan title	Activities	Status	Location
Construction phases – phase 1	Site setup	Illustrative	Vol 16 Albert Embankment Foreshore figures – Section 1
Construction phases – phase 2	Shaft construction Tunnelling	Illustrative	Vol 16 Albert Embankment Foreshore figures – Section 1
Construction phases – phase 3	Secondary lining Construction of other structures	Illustrative	Vol 16 Albert Embankment Foreshore figures – Section 1
Construction phases – phase 4	Completion of works and reinstatement	Illustrative	Vol 16 Albert Embankment Foreshore figures – Section 1

3.3.13 The methods, order and timing of the construction work outlined herewith are illustrative, but representative of a practical method to construct the works and suitable upon which to base the assessment.

3.3.14 The following physical construction works are described:

a. site setup
b. shaft construction
c. tunnel construction
d. tunnel and shaft secondary lining
e. construction of other structures
f. completion of works and site restoration
g. excavated materials and waste
h. access and movement.

Site setup

3.3.15 Prior to any works commencing the hoarded site boundary would be established and would consist of close boarded hoarding panels to the heights specified in the *CoCP*. Welfare and office facilities would also be set up. Telecommunications, water and power supplies to the site would be established by connecting to local services on Albert Embankment.

3.3.16 Other site works set up at this early stage would include the setting up of the required site access from Albert Embankment. For site access Option A (access from Albert Embankment along Lack's Dock), some shrubs and a security kiosk at the entrance to the existing access road from Albert Embankment would require removal. Some shrubs and trees would also require pruning along the existing Lack's Dock access road. All of the low wall running alongside the existing Lack's Dock access road would require removal in advance of the works (the majority of which would be reinstated post construction)[i].

3.3.17 For site access Option B (access from Albert Embankment along a new temporary access route between Camelford House and Tintagel House) a boundary wall, small tree and steps adjacent to Albert Embankment, a retaining wall to the underground car park, shrubs, a small tree and boundary wall adjacent to Thames Path and the river wall parapet would require removal. Part of the low wall running alongside the existing Lack's Dock access road which is closest to the CSO drop shaft construction working area would also require removal in advance of the works.

3.3.18 Other site works would include the setting up of the required site access from Albert Embankment (including use of the existing Lack's Dock access for site access Options A and B or construction of a new access road between Camelford House and Tintagel House in conjunction with occasional use of Lack's Dock for site access Option B), introduction of

[i] These preparation works would not be required under access Option B as only one side of Lack's Dock would be used in this option.

the required traffic management activities, modifications to the Thames Path and temporary services and utility diversions.

3.3.19 It has been assumed that two temporary works cofferdams would extend out from the land from the existing river wall to create two working platforms during construction. The maximum extent of the temporary works in the river is defined on the parameter plan (see Section 3.2 and separate volume of figures).

3.3.20 The piles used to form the temporary cofferdam would be driven into the impermeable clays from a jack-up barge. The top level of the outer wall of the cofferdam would be set to existing flood defence level to maintain the level of defence during construction.

3.3.21 A concrete campshed would be constructed along the western face of the temporary cofferdam for the shaft structure for barges to sit safely on the river bed. The area of the campshed has been assumed to be approximately 1,300m^2. It is assumed that no dredging would be required at this site, although it is likely that there would be some disturbance to the riverbed during construction of the cofferdam and campshed.

3.3.22 For the purpose of this assessment it is assumed that the piles would be driven using vibration piling techniques although the intention would be to seek to maximise the use of silent piling techniques where reasonably practicable.

3.3.23 It is assumed for the assessment that the majority of foreshore material within the temporary cofferdams would remain in situ. For structural reasons, soft material located adjacent to the perimeter of the temporary cofferdams and adjacent to the river wall would be removed. The soft material includes silt, peat and other materials. Removal of this material would ensure that any settlement of the cofferdam fill material does not adversely affect the ties between the walls of the twin walled temporary cofferdam leading to structural difficulties. All soft material within permanent cofferdams would be removed to ensure sound foundations for permanent construction.

3.3.24 The exact extent and depth of the foreshore deposits to be removed at each site would be informed by geotechnical investigations. Areas of removed material would be filled with gravel similar to the existing bed material. Cofferdam fill material would then be placed onto the foreshore on top of a geotextile layer. Suitable sized plant would be utilised to reduce potential load impacts on the foreshore. A drain sump would be maintained within the filled cofferdam to enable any water entering the cofferdam to be pumped back to river. The CSO shaft construction (see below) would commence once the cofferdam is in place as described.

3.3.25 Monitoring of potential scour would be undertaken during the temporary construction works. The need for scour protection to the cofferdam would be identified using the approach set out in the *Scour Monitoring and Mitigation Strategy* (see Vol 3 Appendix L.4).

3.3.26 Internal site roads, plant and material storage areas, offices, welfare and workshops would be established on the cofferdam.

Shaft construction

3.3.27 Major plant required for the main shaft construction would include cranes, excavators, dumpers, diaphragm wall rigs, bentonite silos, separation plant, water tanks, compressors, and air receivers.

3.3.28 The shaft would be constructed by diaphragm wall construction techniques and have a cast *in situ* secondary lining.

3.3.29 The first stage in the construction of each section of diaphragm wall would be the excavation and setting of inner and outer guide walls. These guide walls would retain the ground and allow excavation for the diaphragm walls between them. During diaphragm wall excavation, the trench would be filled with bentonite for ground support; on completion of excavation cycle, steel bar reinforcement cages would be lowered in before concrete is pumped into the trench in order to displace the bentonite and form a solid wall panel.

3.3.30 This process is repeated for each diaphragm wall panel in order to create the full circle of the shaft. Diaphragm wall excavated material would be processed as required and then loaded onto a lorry for transport off site.

3.3.31 The size of the diaphragm wall panels would require an extended working day for each panel to enable the concrete pour to be completed.

3.3.32 The diaphragm wall would be taken to a depth suitable to reduce the flow of water into the shaft. Grouting at the toe of the diaphragm wall and base would also be required to reduce the inflow of water. Dewatering would need to be undertaken as described below.

3.3.33 The shaft excavation would commence after the diaphragm walls are complete. The guide walls would be broken out, and the soil within the diaphragm walls excavated to expose the walls. The excavator within the shaft would load shaft skips, hoisted by crawler crane, depositing the spoil within the excavated material handling area. After any required treatment, the material would be loaded onto a barge for transport off site. Once the excavation is complete, a steel reinforced concrete base plug would be formed at the base of the shaft.

3.3.34 It is anticipated that dewatering would be required. Dewatering wells would be drilled from the surface from within the shaft (a process known as ‘internal dewatering’) and groundwater extracted via pumps. These pumps would be operational during shaft excavation. It is assumed that extracted ground water would be discharged directly into the River Thames after being treated through a settlement system. Extracted water would be sampled on a regular basis to check water quality.

Tunnel works

3.3.35 To connect the drop shaft to the main tunnel, a 3.2m internal diameter connection tunnel would be driven approximately 24m from the CSO drop shaft to connect with the main tunnel at a reception chamber. This chamber would be enlarged to approximately 9m in diameter. It would be constructed using sprayed concrete lining (SCL) techniques.

3.3.36 The excavated material would be removed from the tunnel to a temporary stockpile on the surface prior to loading to barge for onward disposal.

3.3.37 Tunnel portals, to reinforce the connection between the shaft and connection tunnel, would be constructed in the shaft lining. The portals would consist of cast *in situ* concrete, with a sealing arrangement as required, tied to the shaft lining.

3.3.38 Dewatering and ground treatment would be required for the connection tunnel to main tunnel.

Secondary lining of shaft and connection tunnel

3.3.39 Secondary lining is an additional layer of concrete placed against the inside of a tunnel's primary concrete segmental lining for watertightness and to improve the overall structural durability. For the purposes of assessment, it has been assumed that the connection tunnel would have a reinforced concrete secondary lining.

3.3.40 It has been assumed that on completion of the tunnelling phase, a batching plant would be mobilised to site. The plant would supply the secondary lining of the connection tunnel. Concrete would be batched on surface and pumped or skipped to the tunnel.

3.3.41 The secondary lining of the connection tunnel would be constructed by installing steel reinforcement, erecting a cylindrical shutter within a short length of tunnel and pumping concrete into the gap between the shutter and the primary lining. Once the concrete has hardened sufficiently, the shutters would be removed and erected in the next section of tunnel.

3.3.42 It is assumed that the lining of the CSO drop shaft would be made of reinforced concrete placed inside the shaft's primary support. The CSO drop shaft secondary lining is likely to be constructed after the connection tunnel construction. It would be formed with a continuous slip form formwork system or fixed shutters. The shutter would be assembled at the bottom of the shaft, slowly and continuously winched up the shaft whilst setting steel reinforcement from a working platform and continuously pumping concrete.

3.3.43 When the secondary lining is complete the internal structures including the vortex and drop tube would be shuttered and concreted.

Construction of other structures

3.3.44 The existing storm relief sewers that discharge to the River Thames either side of Vauxhall Bridge would be extended through or around the temporary cofferdam, maintaining flows during the works. These would be fully enclosed with flap valves fitted to prevent tidal surcharge.

3.3.45 To enable the interception structure site to be accessed, a temporary ramp from foreshore level up to flood defence level would be constructed. This would be removed on completion of the works.

3.3.46 Air management structures comprising an underground air treatment chamber, ventilation columns and underground louvre chambers for ventilation control, electrical and control kiosks and local control pillars would also be built and commissioned.

3.3.47 Sheet pile walls would be used to provide support within which the underground chambers would be constructed. Walls would be constructed to a depth to minimise ground water ingress into the excavation, but small pumps would be utilised to manage any ground water that does seep through. The pumps would discharge to the River Thames after being treated through a settlement system.

3.3.48 The walls of the interception chamber would be formed by *in situ* concrete techniques. Concrete would be delivered to site and either pumped or skipped to the chamber.

3.3.49 A culvert would be constructed to intercept the Brixton Storm Relief Sewer CSO outfall at the north of the bridge. A pipe would be laid to intercept the Clapham Storm Relief Sewer CSO outfall at the south of the bridge and transfer flows beneath the bridge to the interception structure at the north of the bridge. Both the pipe and culvert would be constructed through the existing foreshore within a retained excavation.

3.3.50 The connection culvert between the interception chamber and the drop shaft would be constructed, using SCL techniques similar to those described for the connection tunnel.

3.3.51 The new river walls around both sites would be built within the temporary cofferdams. It is assumed that the new river wall around the shaft site would be constructed as a piled wall which incorporates both driven tubular and steel sheet piles and a reinforced concrete structure. It is assumed that the new river wall around the interception structure site would be constructed as a terraced wall comprising cast in situ concrete terraces which would be backfilled with substrates suitable for growing intertidal habitat.

3.3.52 Once the walls are in place, the reinforced concrete would be completed either in situ or using precast components. This would include the required architectural finishes.

Completion of works and site restoration

3.3.53 On completion of the main construction (outlined above) the new river walls would be finished prior to removal of the temporary cofferdams to ensure flood protection.

3.3.54 Once the cofferdam fill is removed, the geotextile layers would be removed and the areas of the foreshore where permanent scour protection is required would be excavated by approximately 1.5m by an excavator.

3.3.55 It is assumed for the assessment that permanent scour protection and new outfall apron would consist of loose large stone placed just below foreshore level. The size and type of the stone is to be defined. It is assumed therefore that a 1m depth of stone would be placed up to 0.5m below the existing foreshore level within the zone indicated on the Site works parameter plan (see separate volume of figures – Section 1). This permanent protection would be within the area of the temporary cofferdams.

3.3.56 Once the permanent scour protection is in place, the bed would be reinstated to match the existing river bed conditions as required and the sheet piling forming the temporary cofferdams would then be removed by pulling. Material excavated would be disposed of in accordance with the project's Waste Management procedure.

3.3.57 Once the main elements of construction are completed, the final landscaping works would be undertaken including final treatments and surfaces, planting and installation of street furniture. Final treatments to the river walls would be completed prior to removal of the temporary cofferdams.

Excavated materials and waste

3.3.58 The construction activities described above and in particular the construction of the shaft would generate a large volume of excavated material which would require removal. This is estimated at 125,000 tonnes, the main elements of which would comprise approximately 82,000 tonnes of imported fill (which would require later removal), 6,500 tonnes of mixed materials from the diaphragm wall construction, 4,000 tonnes of made ground, 25,000 tonnes of London Clay, and 8,000 tonnes of Lambeth group.

3.3.59 In addition, it is estimated that approximately 3,000 tonnes of construction waste would be generated including 2,000 tonnes of imported fill and 700 tonnes of concrete.

3.3.60 Excavated materials and construction wastes would be exported from the site in accordance with the *Transport Strategy* (see Access and movement below).

Access and movement

3.3.61 For the purposes of the assessment a single trip to or from the site is referred to as a 'movement', while two trips, one to and one from the site, are referred to as a 'lorry' or 'barge'.

3.3.62 The transport strategy requires that the importation of granular fill for the formation of the temporary working area, and the subsequent removal of fill would be by barge. It is also anticipated that the removal of shaft and 'other' excavated material would be by barge. The assessment assumes 90% of these materials would be taken by river, with the residual 10% transported by road to account for periods where river transport is not available or the material is unsuitable for transport by barge,

3.3.63 The highest barge movements would occur during cofferdam construction. Peak daily barge numbers, averaged over a one month period, would be four barges per day, equivalent to eight barge movements. It is estimated that total barge numbers for this site would be 581, equivalent to 1,162 barge movements over the construction period. Barge numbers are based upon an assessed barge size of 350T. Barges would sit on campsheds adjacent to the northern most temporary cofferdam during periods of low tide and it is assumed that they would be moved by tugs at this site. It is estimated that tugs would be present at this site for approximately 20 minutes when delivering/collecting barges.

3.3.64 The highest lorry movements at the site would occur during cofferdam construction. The peak daily vehicle numbers at this time, averaged over a one month period, are estimated to be 19 HGV lorries, equivalent to 38 movements per day. It is estimated that total vehicle numbers for this site would be in the order of 6,600 HGV lorries, equivalent to 13,200 movements over the construction period.

3.3.65 It is envisaged that the site access point is via a left turn into the site access road from Albert Embankment (A3036) and the egress is a left turn back out of the site access road onto Albert Embankment. The point of access on and off Albert Embankment would vary depending on which site access option is taken forward. For access Option A the site access point would be from the existing Lack’s Dock access road. For access Option B the main site access point would be from a temporary access road constructed between Camelford House and Tintagel House

3.3.66 For access Option A, construction access would be overseen by a site security guard. For security reasons (due to the proximity of the site to Vauxhall Cross) there would also be a temporary off site marshalling and search area for security checking delivery vehicles before they access the site. It would be located within a maximum fifteen minute drive of the site. The location of the search area has not yet been identified and is not included in the *Draft DCO*. It would be the subject of a separate planning application if required. The search area would not be required for access Option B between Camelford House and Tintagel House. The security services would require advanced notice of occasional access along Lack’s Dock and vehicles would be checked before arrival.

3.3.67 Access through the site to the foreshore would be maintained for the amphibious tourist vehicles run by London Duck Tours. Due to work along the Thames embankment, the Thames Path would require diversion around the works.

3.3.68 The Thames Path running along the river embankment would be temporarily diverted along Albert Embankment. Appropriate diversion signage would be deployed.

3.3.69 A *Traffic management plan* would be developed for the site, produced, coordinated and implemented by the contractor.

3.3.70 A *Draft Project Framework Travel Plan*, which accompanies the application, has been produced setting out the requirements and guidelines for the site-specific *Travel plans* to be developed by the contractor.

3.4 Operational assumptions

3.4.1 This section provides details of the assumptions which have been made for the operational phase for the purposes of the EIA. Unless otherwise also listed in Section 3.2, the details given are illustrative and do not form part of the project for which consent is sought.

3.4.2 The details given are considered likely to represent the likely approach, given the site constraints, the adjacent land uses and the operational requirements. This section describes only the main operational structures and activities with the focus on those that are relevant for the assessment of environmental effects.

3.4.3 The operational structures are described first, followed by the assumed maintenance regime.

3.4.4 Once operational the project would divert the majority of current CSO discharges via the CSO shaft and connection tunnel to the main tunnel and then via the Lee Tunnel for treatment at Beckton Sewage Treatment Works. The number of CSO discharges from the Clapham Storm Relief Sewer would be reduced from six spill events in a typical year to approximately once in a typical year at an average rate of 7,900m^3 per year. The number of CSO discharges from the Brixton Storm Relief Sewer would be reduced from 29 spill events in a typical year to approximately once in a typical year at an average rate of 5,700m^3 per year.

Operational structures

3.4.5 For the purposes of the application, each of these structures is shown as being located within a defined zone in which the structure would be located. The operational structures listed within the proposed schedule of work description in Section 3.2 along with the relevant plans, form part of the proposed development for consent. The defined zones for the structures are shown on the site works parameter plan.

3.4.6 The heights of the main ventilation columns are defined and also form part of the project for consent (see Section 3.2). The following text provides additional clarification on the assumed form, purpose, function and working of these structures where this is considered helpful to the reader.

3.4.7 The assessment for each of the environmental topics has been based on the approximate dimensions and siting of the structures to ensure the assessment is robust. For example, the lower height for the ventilation column would typically generate higher odour impacts than a higher height and so the lower height limit has been modelled in the assessment. For other topics such as townscape, the upper height may be more important and has therefore been assessed. The approach that has been adopted in this regard is explained within each topic assessment section, where necessary.

3.4.8 The approximate dimensions provided for underground structures are internal dimensions which are determined by the hydraulic requirements at particular sites.

3.4.9 Once constructed and operational the structures listed in the following sections would remain on site.

Shaft

3.4.10 The location, diameter and depth of the shaft are described in Section 3.2.

3.4.11 The shaft cover slab and surfacing would be finished at a level approximately equal to the existing footpath level. A parapet wall would extend to a minimum of flood defence level around the site. The new river wall around the shaft site would enclose the existing wall adjacent to Lack's Dock slipway at the south of the shaft site.

3.4.12 Ground level access covers on the shaft would be used for access/egress by maintenance vehicles and personnel during planned inspections of the shaft.

Chamber and culverts

3.4.13 The interception chamber for both Brixton and Clapham CSOs would be in the foreshore just to the north of Vauxhall Bridge. This would include a new CSO outlet structure with flap valves. The chamber is to be below ground within a new area of reclaimed land in the foreshore with a parapet set above flood defence level. There would be covers on top of the chambers to allow access and inspection. There would be three culverts below ground, one to transfer flows from the Clapham Storm Relief Sewer CSO outfall to the interception chamber, one to transfer flow from the Brixton Storm Relief Sewer CSO to the interception chamber and a third culvert to transfer intercepted flows from the interception chamber to the drop shaft.

3.4.14 The interception chamber would be connected to the drop shaft by a connection culvert under the foreshore driven from the drop shaft, which would be approximately 100m long with an internal diameter of approximately 3.2m.

River wall

3.4.15 The location of the new river wall/balustrade is defined in Section 3.2. An open balustrade would be constructed along the front of the new shaft foreshore structure. A solid wall would be constructed around the top of the interception structure, built to the flood defence level and tied in with existing flood defences at both ends.

Air management structures

3.4.16 The heights and locations of above ground air management structures, which comprise the ventilation columns, are defined in Section 3.2.

3.4.17 Below ground structures would contain air treatment and connect the ventilation columns to the structures that they are ventilating. These would have ground level covers to allow access and inspection.

Electrical and control kiosks

3.4.18 The height and location of the above ground electrical and control kiosks and a small local control pillar are defined in Section 3.2. The electrical and control kiosks would contain gas monitors, hydraulic controls, electrical and control panels and metering equipment.

Permanent restoration and landscaping

3.4.19 As shown on the proposed indicative landscape plans, the area above the shaft structure would be finished with hardstanding to allow maintenance vehicle and crane access to the covers on top of the shaft. The area of hardstanding around the drop shaft would form an extension to the Thames Path and would usually be publicly accessible, but Thames Water would retain a right of access over it and may need to close off areas or the Thames path for short periods to carry out maintenance. The area above the interception structure would also be finished with hardstanding, but would be closed to public access.

3.4.20 Access to the structures would be from Albert Embankment via Lack's Dock. Vehicles would turn either north to the site through a line of removable bollards or south to the interception chamber site along the Thames Path via a gate that would be normally closed. The existing ladder access to the foreshore at the interception structure would be reinstated. Secure fencing to the area below the bridge would be reinstated to match existing like for like and provide a secure access to the electrical and control kiosks. The design would respect the character and setting of the Grade II* listed Vauxhall Bridge. The terraces around the interception structure would provide inter-tidal habitat using pre-established planting. Planting along Lack's Dock would replace that lost during construction. Three new semi mature London Plane trees would be planted on the shaft structure to separate the riverside walkway from the operational area.

3.4.21 New lighting to the Thames Path, foreshore and interception structures would be provided. Existing lighting on the Thames Path would be reinstated in accordance with the overall lighting design.

Typical maintenance regime

3.4.22 A light commercial vehicle would undertake three to six monthly maintenance works. This would be carried out during normal working hours and would take approximately half a day. Similar maintenance access would be required for operatives on foot only to the interception chamber site. Additionally, once every ten years, more substantial maintenance work would be carried out at both the shaft site and the interception chamber site. This would be carried out in normal working hours. Vehicular requirements for these visits would include two mobile cranes and associated support vehicles and equipment.

3.5 Base case and cumulative development

3.5.1 The assessments undertaken for this site take account of other relevant development projects within the vicinity of the site which are under construction, permitted but not yet implemented or submitted but not yet determined. In order to identify the relevant developments for consideration, the Planning Inspectorate, local planning authorities, Greater London Authority and Transport for London have been consulted on the methodology (see Volume 2) and asked to assist in identifying and verifying the development schedules included in the assessment. A schedule is provided in Vol 16 Appendix N of the resulting development projects, a description of what is proposed and assumptions on phasing. Longer term development projects may be included under both base case, where construction precedes that of the Thames Tideway Tunnel site, and cumulative where construction or operation occurs at the same time as a given Thames Tideway Tunnel site.

3.5.2 The development projects which have been included under base case, cumulative or both for the assessment of the proposed development at Kirtling Street are listed below. A map showing their location is included in Vol 16 Figure 3.5.1:

a. 2-14 Tinworth Street, and 108 - 110 Vauxhall Walk

b. Land at St Georges Wharf (Vauxhall Tower)

c. Hampton House, 20 Albert Embankment London

d. Vauxhall Square Cap Gemini Site (plot bounded by Parry Street, Bondway, Miles Street and Wandsworth Road)

e. Market Towers

f. Island Site Vauxhall Cross

g. 10 Albert Embankment (Wah Kwong House)

h. 81 Black Prince Road (Parliament House)

i. Vauxhall Sky Gardens, 143-161 Wandsworth Road

j. US Embassy - Land on south side of Nine Elms Lane incorporating Ponton Road

k. Nine Elms Sainsbury's, Wandsworth Road

l. Embassy Gardens, Land to the south of Nine Elms Lane comprising DHL Depot and 1-12 Ponton Road and 51 Nine Elms Lane

m. Post Office Depot, South London Mail Centre Nine Elms Lane

n. Northern Line Extension

3.6 On-site alternatives

3.6.1 Project wide and site selection alternatives are addressed in Volume 1. This section describes on-site alternatives that have been considered and provides the main reasons why these alternatives (to the proposed design) have not been adopted.

3.6.2 Vol 16 Table 3.6.1 below identifies those items for which alternatives have been considered, the alternatives and provides the main reasons why the alternatives were not taken forward.

Vol 16 Table 3.6.1 Albert Embankment Foreshore – on-site alternatives

Item	Alternatives considered	Reason not progressed
Separate interception structures on either side of bridge	One chamber for each CSO on either side of the bridge abutment	Construction of Clapham chamber on south side of bridge would impact the Victoria line tunnels in the vicinity

Item	Alternatives considered	Reason not progressed
Vehicular access	Access directly through Albert Embankment Gardens in front of Peninsula House	Considered less suitable as the route went through a public park and in front of a residential building.
Access to operational structure	Making the interception foreshore structure publicly accessible	Security concerns regarding the creation of new open space in close proximity to the Vauxhall Cross building

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.16**

Volume 16: Albert Embankment Foreshore site assessment

Section 4: Air quality and odour

APFP Regulations 2009: Regulation **5(2)(a)**

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January 2013

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

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Thames Tideway Tunnel

Environmental Statement

Volume 16: Albert Embankment Foreshore site assessment

Section 4: Air quality and odour

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4 Air quality and odour

4.1 Introduction

4.1.1 This section presents the findings of the assessment of the likely significant air quality and odour effects of the proposed development at the Albert Embankment Foreshore site. This assessment covers the effects associated with both the site access options. The project-wide air quality effects are described in Volume 3 Project-wide effects assessment.

4.1.2 The proposed development has the potential to affect air quality and odour due to:

a. construction traffic on the roads leading to an increase in vehicle emissions (air quality)

b. emissions from tugs pulling river barges (air quality)

c. emissions from construction plant (air quality)

d. construction-generated dust (air quality)

e. operation of the tunnel, resulting in air emissions (odour).

4.1.3 Each of these impacts is considered within the assessment. As a result the construction assessment for Albert Embankment Foreshore site comprises four separate components: effects on local air quality from construction road traffic; effects on local air quality from tugs (for river barges); effects on local air quality from construction plant; and effects from construction dust. The effects on local air quality from construction road traffic, tugs (for river barges) and construction plant are assessed together (within the same model) while construction dust is assessed separately. The operational assessment considers the potential for nuisance odour emissions from the operation of the tunnel. As set out in the *Scoping Report*, local air quality effects are not assessed during operation on the basis that the only relevant operational source of air pollutants would be from the infrequent visits of maintenance vehicles which would occur in very low numbers, vehicles which would not result in a likely significant effect.

4.1.4 The assessment of air quality and odour presented in this section has considered the requirements of the National Policy Statement for Waste Water sections 4.3 (odour), 4.11 (air quality and emissions) and 4.12 (dust). Further details of these requirements can be found in Vol 2 Section 4.3.

4.1.5 Plans of the proposed development as well as figures included in the assessment for this site are contained in a separate volume (Volume 16 Albert Embankment Foreshore figures). Appendices supporting this site assessment are contained in Vol 16 Appendix B.

4.2 Proposed development relevant to air quality and odour

4.2.1 The proposed development is described in Section 3 of this volume. The elements of the proposed development relevant to air quality and odour are set out below.

Construction

Construction road traffic

4.2.2 During the proposed construction period there would be construction traffic movements[i] in and out of the site.

4.2.3 The highest number of lorry movements in any one year at the Albert Embankment Foreshore site would occur during cofferdam construction (Site Year 1 of construction). The average daily number of vehicle movements during the peak month would be approximately 46 movements per day.

4.2.4 The construction traffic routes, traffic management and access to the site are detailed in Section 12 Transport.

4.2.5 Construction traffic is likely to affect local air quality as a result of increasing traffic and therefore emissions on the road network.

Tugs for river barges

4.2.6 River barges may affect local air quality through direct emissions from the tugs pulling them.

4.2.7 The average daily number of barge movements during the peak month would be eight barge movements a day in Site Year 1 of construction (although the peak year in terms of tug numbers would be Site Year 3 of construction). The emissions associated with the tugs are presented in Vol 16 Appendix B.3.

Construction plant

4.2.8 Construction plant is likely to affect local air quality from direct exhaust emissions associated with the use and movement of the plant around the site.

4.2.9 There are a number of items of plant to be used on site that may produce emissions that could affect local air quality. Examples of such plant are excavators, generators and dumper trucks.

4.2.10 Typical construction plant which would be used at the Albert Embankment Foreshore site in the peak construction year and associated emissions data are presented in Vol 16 Appendix B.4.

Construction dust

4.2.11 Activities with the potential to give rise to dust emissions from the proposed development during construction are as follows:

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[i] A movement is a construction vehicle moving either to or from the site.

a. site preparation and establishment

b. demolition of existing infrastructure and buildings

c. materials handling and earthworks

d. construction traffic – from moving over unpaved ground and then tracking out mud and dirt onto the public highway (termed 'trackout' hereafter).

4.2.12 At the Albert Embankment site there would be approximately 220m^3 of demolition material generated while the amount of amount of material moved during the earthworks would be approximately 210,000 tonnes. The volume of building material used during construction would be approximately 10,000m^3.

Code of Construction Practice

4.2.13 Appropriate dust and emission control measures are included in the *Code of Construction Practice* (*CoCP)*[ii] *Part A* (see Section 7) in accordance with the *London Councils Best Practice Guidance* (GLA and London Councils, 2006)[1]. Measures incorporated into the *CoCP* to reduce air quality impacts include measures in relation to vehicle and plant emissions, measures to reduce dust formation and re-suspension, measures to control dust present and measures to reduce particulate emissions. These would be observed across all construction and demolition activities at the Albert Embankment Foreshore site.

4.2.14 The effective implementation of the *CoCP Part A* measures is assumed within the assessment.

Operation

4.2.15 A ventilation structure would treat air released from the tunnel. The air would be treated by passing air through two carbon filters housed in a below ground air treatment chamber. Natural pressure during tunnel filling would allow air to pass passively without the need for fans. The capacity of each passive filter would be 2.0m^3/s. The maximum air release rate from each filter during a typical year is expected to be 0.65m^3/s, therefore all air in a typical year would be treated through the passive filter. No nuisance odours are therefore expected.

4.2.16 Air would be released from the ventilation columns for about 25 hours in a typical year, all of which would have passed through the passive filter. For the remaining hours, no air would be released although air intake would occur as the tunnel is emptied

Environmental design measures

4.2.17 A carbon filter would be included as part of the ventilation shaft design and construction. The passive filter would remove odours by adsorption onto the filter. Full details of the Thames Tideway Tunnel ventilation system can be found in the *Air Management Plan*.

[ii] The *Code of construction practice* (CoCP) is provided in Vol 1 Appendix A. It contains general requirements (Part A), and site specific requirements for this site (Part B).

4.3 Assessment methodology

Engagement

4.3.1 Volume 2 Environmental assessment methodology (Section 4.2) documents the overall engagement which has been undertaken in preparing the *Environmental Statement*. Specific comments relevant to this site for the assessment of air quality and odour are presented here (Vol 16 Table 4.3.1).

Vol 16 Table 4.3.1 Air quality and odour – stakeholder engagement

Organisation	Comment	Response
London Borough (LB) of Lambeth, scoping response, June 2011	What measures will be undertaken for dust suppression. The Council would suggest that wheel washes be used. How will the project ensure no mud is carried onto the public highway and what arrangements are/will there be should the wheel wash fail?	The measures outlined in the London Councils Best Practice Guidance1 for a high risk site would be followed. These measures are detailed in the *CoCP Part A*.
LB of Lambeth, August 2011	Agree monitoring locations with LB of Wandsworth	Locations agreed with LB of Lambeth Project Manager - Air Quality.
LB of Lambeth, August 2011	Odour complaints in the area should be considered	No relevant complaints.
LB of Lambeth, scoping response, June 2011	The use of the river for construction traffic should be maximised to mitigate the transport impacts of the scheme	River transport has been maximised in order to minimise the effects on local air quality in the vicinity of Albert Embankment Foreshore site.

Baseline

4.3.2 The baseline methodology follows the methodology described in Vol 2. There are no site specific variations for identifying baseline conditions for this site.

Construction

4.3.3 The assessment methodology for the construction phase follows that described in Vol 2. There are no site specific variations for undertaking the construction assessment of this site.

4.3.4 Section 4.5 details the likely significant effects arising from the construction at the Albert Embankment Foreshore site. There are no other Thames Tideway Tunnel project sites which could elevate construction dust nuisance within the assessment area (see para. 4.3.5 below). With regard to local air quality, the effect of all relevant traffic associated with Thames Tideway Tunnel project sites using the highway network in the vicinity of the site is taken into account in the assessment as traffic data used for the assessment includes traffic associated with all Thames Tideway Tunnel sites..

Construction assessment area

4.3.5 The assessment area for the local air quality assessment during construction covers a square area of 600m by 600m centred on the Albert Embankment Foreshore site. This assessment area has been used for the assessment of road transport, tugs for river barges, construction plant and construction dust and has been selected on the basis of professional judgement to ensure that the effects of the Albert Embankment Foreshore site are fully assessed. A distance of 200m is generally considered sufficient (Highways Agency, 2007)[2] to ensure that any significant effects are considered. The selected assessment area exceeds this considerably.

Construction assessment year

4.3.6 The peak construction year in terms of construction traffic movements (Site Year 1 of construction) has been used as the year of assessment for construction effects (construction road and river transport, construction plant and construction dust) in which the development case (with the Thames Tideway Tunnel project) has been assessed against the base case (without the Thames Tideway Tunnel project) to identify likely significant effects of the Thames Tideway Tunnel project. The peak construction year (Site Year 1 of construction) in terms of construction traffic movements is expected to lead to the largest local air quality effects, so has been used in preference to the peak year in terms of the largest number of barge movements (Site Year 3 of construction). Additionally as air quality is predicted to improve in future years, Site Year 1 of construction represents a worse-case compared with Site Year 3 of construction.

4.3.7 The assessment of construction effects also considers the extent to which the effects on local air quality would be likely to be materially different should the programme for the Thames Tideway Tunnel project be delayed by approximately one year.

Other developments

4.3.8 As indicated in the site development schedule (see Vol 16 Appendix N), there are nine other new developments (Hampton House, Eastbury House, Riverwalk House, 1-9 Bondway/4-6 South Lambeth Place, St Georges Wharf (Vauxhall Tower), Vauxhall Square Cap Gemini, Market Towers, Island Site Vauxhall Gyratory and 2-14 Tinworth Street/108-110 Vauxhall Walk) identified within the air quality assessment area. Seven of these (Hampton House, Eastbury House, Riverwalk House, 1-9 Bondway/4-6 South Lambeth Place, St Georges Wharf (Vauxhall Tower), Market Towers and 2-14 Tinworth Street/108-110 Vauxhall Walk) would be complete and operational by Site Year 1 of construction and are therefore considered as receptors in the air quality assessment. The Vauxhall Square Cap Gemini and Island Site Vauxhall Gyratory developments would be under construction in Site Year 1 of construction and are therefore considered in the cumulative effects assessment. Trips associated with all the developments are taken into account in the traffic data used for the air quality assessment.

Operation

4.3.9 The odour assessment methodology for the operational phase follows that described in Vol 2. There are no site specific variations for undertaking the operational assessment of this site.

4.3.10 Section 4.6 details the likely significant effects arising from the operation at the Albert Embankment Foreshore site. There are no other Thames Tideway Tunnel sites which could give rise to additional effects on odour within the assessment area (see para. 4.3.11 below) and therefore no other Thames Tideway Tunnel sites are considered in this assessment.

Operational assessment area

4.3.11 Odour dispersion modelling has been carried out over an area of 700m by 600m centred on the Albert Embankment Foreshore site. The assessment area has been selected on professional judgement on the basis of it being considered the potential maximum extent of the impact area.

Operational assessment year

4.3.12 The assessment undertaken for a typical use year (as described in Vol 2) applies equally to all operational years. Therefore no specific year of operation has been assessed.

Other developments

4.3.13 As indicated in the site development schedule (see Vol 16 Appendix N), there are nine other new developments (Hampton House, Eastbury House, Riverwalk House, 1-9 Bondway/4-6 South Lambeth Place, St Georges Wharf (Vauxhall Tower), Vauxhall Square Cap Gemini, Market Towers, Island Site Vauxhall Gyratory and 2-14 Tinworth Street/108-110 Vauxhall Walk) identified within the assessment area of the Albert Embankment Foreshore site, all of which are relevant to the odour assessment being sensitive properties in close proximity to the site. These developments are relevant to the odour assessment as they represent sensitive receptors within 300m of the site. These developments are therefore considered as receptors in the odour assessment. The proposed buildings at the St Georges Wharf (Vauxhall Tower) and 2-14 Tinworth Street/108-110 Vauxhall Walk have also been included in the modelling as these buildings may affect dispersion. Due to the nature of the developments there are no cumulative operational effects to assess.

Assumptions and limitations

Assumptions

4.3.14 The general assumptions associated with this assessment are presented in Vol 2.

Construction

4.3.15 The site specific assumptions in terms of model input are set out in Vol 16 Appendix B.

Operation

4.3.16 The site specific assumptions in terms of the assumed capacity of the carbon filter and air release rate used for the odour dispersion modelling are described in paras. 4.2.15 to 4.2.17.

4.3.17 Odour dispersion modelling only includes emissions from the ventilation structures and does not take account of background concentrations due to other sources. Background odour concentrations in the area are assumed to be low as there has only been one recorded complaint in the surrounding area over recent years (see para. 4.4.12) and seasonal spot measurements of hydrogen sulphide (H_2S) carried out in 2011/12 indicate that concentrations are typical of urban areas (Michigan Environmental Science Board, 2000)[3].

4.3.18 Following dispersion modelling, the maximum concentration predicted at any location was reported whether this was at a building where people could be exposed or on open land. As a worst case assumption, it was assumed that this is a relevant receptor. This means that should the ventilation structure be moved within the identified parameter plan (see Site Parameter Plan), the impact would not be worse than that reported in Section 4.6.

Limitations

4.3.19 The general limitations associated with this assessment are presented in Vol 2.

Construction

4.3.20 As the PM_{10} monitoring site (Broadway Interchange LB5) located within the vicinity of the Albert Embankment Foreshore site has poor data capture and is affected by the London Underground vent nearby, it has not been possible to verify PM_{10} modelling results using the monitoring from this site[iii]. The adjustment factor derived for NO_X (from a comparison of modelled and monitored NO_X data) has therefore been applied to the PM_{10} modelling results.

[iii] Model verification refers to checks that are carried out on model performance at a local level. This basically involves the comparison of predicted (modelled) versus measured concentrations. Where there is a disparity between the predicted and the measured concentrations, the first step should always be to check the input data and model parameters in order to minimise the errors. If required, the second step would be to determine an appropriate adjustment factor that can be applied to the modelled traffic contribution.

4.3.21 It is noted that the 2011 PM_{10} monitoring data from the closest monitoring station (unsuitable for verification purposes) reported in the baseline (Section 4.4) are not yet fully ratified[iv]. The lack of full ratification does mean that the characterisation of the existing baseline PM_{10} concentration is less certain. However, there are no direct implications for the assessment, as this concentration is not used in the assessment for verification purposes or as the background concentration used in the modelling.

Operation

4.3.22 There are no additional limitations specific to the odour assessment of this site.

4.4 Baseline conditions

4.4.1 The following section sets out the baseline conditions for air quality and odour within and around the site. Future baseline conditions (base case) are also described.

Current baseline

Local air quality

4.4.2 The current conditions with regard to local air quality are best established through long-term air quality monitoring.

4.4.3 As part of their duties under Part IV of the Environment Act 1995 (UK Government, accessed 2012)[4], local authorities, especially in urban areas where air quality is a significant issue, undertake long-term air quality monitoring within their administrative areas.

4.4.4 There is one continuous monitoring station which collects data pertinent to the Albert Embankment Foreshore site and associated construction traffic routes operated by LB of Lambeth. There are no diffusion tubes operated by LB of Lambeth located in the assessment area. A continuous monitoring station is also operated by the neighbouring local authority; the Westminster City Council, which monitors background NO_2 concentrations relevant to the Albert Embankment Foreshore site. The location of these is shown in Vol 16 Figure 4.4.1 (see separate volume of figures). Monitoring data for these sites for the period 2007-2011 are contained in Vol 16 Table 4.4.1 (NO_2 concentrations) and Vol 16 Table 4.4.2 (PM_{10} concentrations).

[iv] The process of data ratification generally involves a first level screening of the data (by manual and/or automatic methods), to remove obvious erroneous values. These data will have been suitably calibrated against reference standards. Within the national monitoring networks, these validated data are labelled “provisional”. The secondary process in data ratification involves a more thorough checking of the data, for example, data rescaling to allow for drift in the calibration standards, or data adjustments following site audits, which have identified problems that could not have been identified remotely.

Vol 16 Table 4.4.1 Air quality – measured NO_2 concentrations

Monitoring site	Site type	Annual mean (µg/m^3)					Number of exceedances of hourly standard				
		2011	2010	2009	2008	2007	2011	2010	2009	2008	2007
Continuous monitoring site											
Bondway Interchange (LB5)	Roadside	**77***	**77**	**77****	**83**	NM	4 (178)*	17	12 (194)**	**38**	NM
Horseferry Road (WM0)	Urban background	**41**	**49**	**44**	**40**	37***	0	3	0	1	0***

*Note: * Data capture was 81%, the figure in brackets for the hourly exceedances is the 99.8th percentile. ** Data capture was 88%, the figure in brackets for the hourly exceedances is the 99.8th percentile. *** Data capture was 77%. Emboldened figures indicate an exceedance of the objective / limit value which is 40µg/m^3 for the annual mean and 200µg/m^3 for the hourly mean which can be exceeded 18 times per year. Codes in brackets represent monitoring site identifiers used in Vol 16 Figure 4.4.1 (see separate volume of figures). NM - Not monitored.*

Vol 16 Table 4.4.2 Air quality – measured PM_{10} concentrations

Monitoring site	Site type	Annual mean (µg/m^3)					Number of exceedances of daily standard				
		2011	2010	2009	2008	2007	2011	2010*	2009	2008	2007
Bondway Interchange (LB5)	Roadside	**43***	**43****	**42*****	**52**	**67******	**92***	**76****	**71*****	**160**	**211******

*Note: * Data capture for 2011 only 79%. ** Data capture for 2010 only 78%. *** Data capture for 2009 only 85%. **** Data capture for 2007 only 85%. Emboldened figures indicate an exceedance of the objective / limit value which is 40µg/m^3 for the annual mean and 50µg/m^3 for the daily mean which can be exceeded 35 times per year. Codes in brackets represent monitoring site identifiers used in Vol 16 Figure 4.4.1 (see separate volume of figures). PM_{10} concentrations from Horseferry Road are not included in Vol 16 Table 4.4.2 as data were only collected in 2010 and 2011 with low data capture in both years.*

4.4.5 The NO_2 monitoring at the Bondway Interchange (LB5) roadside site has shown exceedances of the annual mean NO_2 objective / limit value (40µg/m^3) over the last four years. The hourly objective has been met in the last three years, but was exceeded in 2008. The annual mean NO_2 objective / limit value was also exceeded at the Horseferry Road urban background site between 2008 and 2011, whilst the hourly mean objective / limit value was achieved in all years.

4.4.6 The PM_{10} monitoring at the Bondway Interchange site showed that both the annual and daily mean objectives / limit values have been exceeded over the last five years. It is however noted that data capture at this site has been below 90% in every year except 2008.

4.4.7 The northern part of the LB of Lambeth, which includes the Albert Embankment Foreshore site, has been designated as Air Quality Management Area (AQMA) for NO_2. The Albert Embankment Foreshore site is close to the boundaries with the City of Westminster and the LB of Wandsworth, both of which have declared AQMAs for NO_2 and PM_{10} for the whole Borough.

4.4.8 In addition to the local authority monitoring, diffusion tube monitoring has been undertaken as part of the EIA to monitor NO_2 concentrations in the vicinity of the Albert Embankment Foreshore site. This monitoring comprises six diffusion tubes based at the locations identified in Vol 16 Table 4.4.3. The table shows a 2010 annual mean concentration (baseline year), which has been calculated from the measurements made between April 2011 and April 2012 at each of the sites. To calculate the 2010 annual mean NO_2 concentrations, the 2011/12 measurements are adjusted for bias using the co-located diffusion tubes and are then seasonally adjusted. Annual mean NO_2 concentrations, for the period covered by the diffusion tubes, and for the year 2010 have been collated from four nearby background continuous monitoring sites measuring NO_2 and with data capture rates greater than 90%. The average of the ratios between the period and annual means has been used to calculate the seasonal adjustment factor. To enable any bias to be corrected a triplicate site (comprising three diffusion tubes) was established at a continuous monitoring site in Putney (site PEFM4 – see Vol 7); a triplicate site was established at two of the monitoring sites (AEFM5 and HEAM1) near to the Albert Embankment Foreshore site; otherwise all the monitoring locations have single tubes.

Vol 16 Table 4.4.3 Air quality – additional monitoring locations

Monitoring site	Grid reference	Site type	2010 NO_2 annual mean (µg/m^3)
Albert Embankment (AEFM1)	530399, 178333	Roadside	**77.2**
Harleyford Road (AEFM2)	530582, 177986	Roadside	**84.9**
South Lambeth Road	530488, 177960	Roadside	**100.4**

Monitoring site	Grid reference	Site type	2010 NO_2 annual mean ($\mu g/m^3$)
(AEFM3)			
Parry Street (AEFM4)	530319, 177834	Roadside	**107.5**
Wandsworth Road (AEFM5)	530243, 177911	Roadside	**106.5**
Nine Elms Lane / Riverside Court (HEAM1)	529838, 177749	Roadside	**78.7**

Note: Emboldened figures indicate an exceedance of the objective / limit value which is 40µg/m³ for the annual mean.

4.4.9 All six sites recorded concentrations above the NO_2 annual mean standard of 40µg/m³ limit value. The concentrations recorded during the monitoring are similar to those recorded during local authority monitoring at roadside sites and are typical of the high levels in central London.

4.4.10 This monitoring has been used in conjunction with existing LB of Lambeth monitoring to define the baseline situation and also to provide input to model verification.

4.4.11 In addition to monitoring data, an indication of baseline pollutant concentrations in the vicinity of the site has been obtained from the background data on the air quality section of the Defra website (Defra, accessed 2012)[5]. Mapped background pollutant concentrations are available for each 1km by 1km grid square within every local authority's administrative area for the years 2008 to 2020. The background data relating to the Albert Embankment Foreshore site are given in Vol 16 Table 4.4.4 for 2010 (baseline year).

Vol 16 Table 4.4.4 Air quality – 2010 background pollutant concentrations

Pollutant*	2010
NO2 (µg/m³)	48.3
PM10 (µg/m³)	23.7

*Note: * Average of annual means for 1km grid squares centred on 530500, 177500 and 530500, 178500. An average of two squares has been used as the site straddles two 1km grid squares.*

Odour

4.4.12 The LB of Lambeth has not received any odour complaints for the local area over recent years (LB of Lambeth, 2011)[6]. The Thames Water complaints database was reviewed for an area within a 500m radius of the zones identified for the proposed ventilation column over the last five years. The only identified complaint was in 2010, which related to odour from the general sewerage system.

4.4.13 Data gathering for the project included spot measurements of H_2S made near the site, the results of which are summarised in Vol 16 Table 4.4.5

and the monitoring locations shown in Vol 16 Figure 4.4.2 (see separate volume of figures). The highest concentrations, up to 32.1µg/m^3, were measured on 20 February 2012 during westerly wind conditions. These levels are typical of urban areas (Michigan Environmental Science Board, 2000)3 when a faint odour may be detectable on occasions (World Health Organization, 2000)[7] [v].

Vol 16 Table 4.4.5 Odour – measured H_2S concentrations

Location	Grid reference	Date	Time	H_2S concentration (µg/m^3)
Tintagel House (AEFS1)	530354, 178289	28/08/11	10:00:02	0.0
		28/08/11	10:00:31	0.0
		11/10/11	17:21:50	7.5
		11/10/11	17:23:04	6.4
		30/10/11	10:02:47	4.8
		30/10/11	10:03:18	4.6
		20/02/12	15:18:21	32.1
		20/02/12	15:19:44	10.2
		28/02/12	12:08:23	9.2
		28/02/12	12:09:35	11.1
		21/05/12	10:08:55	10.8
		21/05/12	10:09:51	9.8
Lacks Docks (AEFS2)	530325, 178228	28/08/11	10:03:03	0.0
		28/08/11	10:03:38	0.0
		11/10/11	17:26:59	6.6
		11/10/11	17:27:47	6.1
		30/10/11	10:04:37	0.0
		30/10/11	10:05:06	4.3
		20/02/12	15:22:03	28.6
		20/02/12	15:23:36	8.4
		28/02/12	12:11:35	7.7
		28/02/12	12:12:25	7.0
		21/05/12	10:11:51	7.9
		21/05/12	10:12:50	7.1

[v] The H_2S odour detection threshold is 7ug/m^3 which is the level at which 50% of the people on an odour panel who have been proven to have a good sense of smell can just detect the gas in laboratory controlled conditions.

Location	Grid reference	Date	Time	H_2S concentration (μg/m^3)
Vauxhall Cross Building (AEFS3)	530261, 178144	28/08/11	10:05:53	0.0
		28/08/11	10:06:21	0.0
		11/10/11	17:31:54	7.3
		11/10/11	17:32:47	6.0
		30/10/11	10:06:48	0.0
		30/10/11	10:07:21	0.0
		20/02/12	15:26:07	9.3
		20/02/12	15:27:04	7.5
		28/02/12	12:14:45	8.0
		28/02/12	12:15:44	6.9
		21/05/12	10:16:02	8.2
		21/05/12	10:17:30	8.0
Bridge House (AEFS4)	530233, 178089	28/08/11	10:07:38	0.0
		28/08/11	10:08:06	0.0
		11/10/11	17:35:23	7.2
		11/10/11	17:36:24	5.6
		30/10/11	10:09:10	0.0
		30/10/11	10:09:38	0.0
		20/02/12	15:28:31	7.9
		20/02/12	15:29:23	6.6
		28/02/12	12:17:06	7.4
		28/02/12	12:18:04	6.7
		21/05/12	10:18:46	7.1
		21/05/12	10:19:53	6.8
Meteorological conditions: 28/08/11 SW wind up to 2.0m/s, partially cloudy, rain on previous day. 11/10/11 W wind up to 4.7m/s, partially cloudy. 30/10/11 SW wind at 0.5m/s, cloudy, last rain on 27/10/11. 20/02/12 W wind up to 4.1m/s, partially cloudy. 28/02/12 E wind up to 3.4m/s, partially cloudy. 21/05/12 E wind, average speed 2.1m/s.				

Receptors

4.4.14 As set out in Section 4.1 and Vol 2, the air quality assessment involves the selection of appropriate receptors, which are shown in Vol 16 Figure 4.4.3 (see separate volume of figures) and the table below (Vol 16 Table 4.4.6) for the Albert Embankment Foreshore site. All of these receptors are relevant, albeit with different levels of sensitivity to each of the elements of the air quality assessment. The sensitivity of identified receptors has been determined using the criteria detailed in Vol 2.

4.4.15 It is noted that Vol 16 Table 4.4.6 includes receptors associated with the proposed developments at Hampton House, Eastbury House, Riverwalk House, 1-9 Bondway/4-6 South Lambeth Place, St Georges Wharf, Vauxhall Square Cap Gemini, Market Towers, Island Site Vauxhall Gyratory and 2-14 Tinworth Street/108-110 Vauxhall Walk (see site development schedule in Vol 16 Appendix N) for consideration in the air quality and odour assessments.

Vol 16 Table 4.4.6 Air quality and odour – receptors

Receptors (relating to all identified emissions sources)	Approximate distance of modelled receptor from site boundary and direction from site	Receptor sensitivity		
		Air quality (construction traffic/plant and river tugs for barges)	Construction dust (on-site demolition and construction processes)	Odour (ventilation column)
Residential – Bridge House (AEFR11)	Adjacent	High (exposure relevant to annual mean, daily mean and hourly mean standards)	Medium	High
Residential – Peninsula Heights (AEFR5)	25m north	High (exposure relevant to annual mean, daily mean and hourly mean standards).	Medium	High
Residential – 2-14 Tinworth Street/108-110 Vauxhall Walk (AEFR6)*	120m northeast	High (exposure relevant to annual mean, daily mean and hourly mean standards)	Medium	High
Residential – Eastbury House (AEFR20)*	150m northeast	High (exposure relevant to annual mean, daily mean and hourly mean standards)	Medium	High
Residential – Riverwalk House (AEFR22)*	160m northwest	High (exposure relevant to annual mean, daily mean and hourly mean standards)	Medium	High
Residential – 1-9 Bondway/4-6 South Lambeth Place (AEFR21)*	185m southeast	High (exposure relevant to annual mean, daily mean and hourly mean standards)	Medium	High
Residential – St Georges Wharf (Vauxhall Tower) (AEFR12)*	200m south	High (exposure relevant to annual mean, daily mean and hourly mean standards)	Medium	High

Receptors (relating to all identified emissions sources)	Approximate distance of modelled receptor from site boundary and direction from site	Receptor sensitivity		
		Air quality (construction traffic/plant and river tugs for barges)	Construction dust (on-site demolition and construction processes)	Odour (ventilation column)
Residential - Glasshouse Walk (AEFR17)	200m east	High (exposure relevant to annual mean, daily mean and hourly mean standards)	Medium	High
Residential - Hampton House (AEFR1)*	230m northeast	High (exposure relevant to annual mean, daily mean and hourly mean standards)	Medium	High
Residential – Vauxhall Square Cap Gemini (AEFR13)*	250m south	Receptor not relevant as still under construction in Site Year 1 of construction		High
Residential – Market Towers (AEFR18)*	300m southwest	High (exposure relevant to annual mean, daily mean and hourly mean standards)	Medium	High
Residential – Island Site Vauxhall Gyratory (AEFR19)*	300m southwest	Receptor not relevant as still under construction in Site Year 1 of construction		High
Educational - Chelsea College of Art and Design (AEFR2)	225m northwest	Medium (exposure relevant to daily mean and hourly mean standards)	Medium	Medium
Hotel - Park Plaza Riverbank London (AEFR15)	295m northeast	Medium (exposure relevant to daily mean and hourly mean standards)	Medium	High

Receptors (relating to all identified emissions sources)	**Approximate distance of modelled receptor from site boundary and direction from site**	**Receptor sensitivity**		
		Air quality (construction traffic/plant and river tugs for barges)	**Construction dust (on-site demolition and construction processes)**	**Odour (ventilation column)**
Offices - Camelford House (AEFR8)	Adjacent	Low (exposure is relevant for the hourly mean standard only)	Medium	Medium
Offices - Tintagel House (AEFR7)	Adjacent	Low (exposure is relevant for the hourly mean standard only)	Medium	Medium
Offices - Vauxhall Cross (AEFR10)	Adjacent	Low (exposure is relevant for the hourly mean standard only)	Medium	Medium
Recreational – River Thames (AEFR14)	41m west	Low (exposure is relevant for the hourly mean standard only)	Low	Low
Recreational - Albert Embankment Gardens (AEFR3)	85m northeast	Low (exposure is relevant for the hourly mean standard only)	Medium	Medium
Recreational - Thames Path (AEFR4)	62m north	Low (exposure is relevant for the hourly mean standard only)	Low	Low
Recreational - Spring Gardens (AEFR9)	110m east	Low (exposure is relevant for the hourly mean standard only)	Medium	Medium
Commercial - Vauxhall Bus Station (AEFR16)	137m southeast	Low (exposure is relevant for the hourly mean standard only)	Medium	Medium

** Denotes receptor that is altered or constructed after the baseline year.*

Construction base case

4.4.16 The base case conditions for the construction assessment year would be expected to change from the baseline conditions due to modifications to the sources of the air pollution in the intervening period.

4.4.17 For road vehicles, there would be an increase in the penetration of new Euro emissions standards (Defra , accessed 2012)[8] to the London vehicle fleet between the current situation and Site Year 1 of construction. Euro standards define the acceptable exhaust emission limits for new vehicles sold in the EU. These standards are defined through a series of European Union directives staging the progressive introduction of increasingly stringent standards over time. The uptake of newer vehicles with improved emission controls should lead to a reduction in NO_2 and PM_{10} concentrations over time. These changes in fleet composition and the emissions are covered in this assessment.

4.4.18 Other emissions sources should also reduce due to local and national policies. Therefore, the non-road sources of the background concentrations used in the modelling have been reduced in line with Defra guidance LAQM.TG(09) (Defra , accessed 2009)[9].

4.4.19 Background pollutant concentrations for Site Year 1 of construction (peak construction year) used in the modelling are shown in Vol 16 Table 4.4.7. The background NO_2 concentration has been taken from the Horseferry Road continuous monitoring site (WM0) and the background PM_{10} concentration has been taken from the Defra mapped background data5 due to low data capture at the Horseferry Road monitor.

Vol 16 Table 4.4.7 Air quality – annual mean background pollutant concentrations

Pollutant	Baseline (2010)	Peak construction year (Site Year 1 of construction)
NO_2 (µg/m^3)*	48.9	39.3
PM_{10} (µg/m^3)**	23.1	21.5

** Derived from monitored NO_2 concentrations at WM0 monitoring station in 2010.*
*** Average of annual means for 1km grid squares centred on 530500, 177500 and 530500, 178500, adjusted to ensure local A roads are not double counted.*

4.4.20 As indicated in para. 4.3.8, the base case in Site Year 1 of construction takes into account seven proposed developments (Hampton House, Eastbury House, Riverwalk House, 1-9 Bondway/4-6 South Lambeth Place, St Georges Wharf (Vauxhall Tower), Market Towers and 2-14 Tinworth Street/108-110 Vauxhall Walk), including them as receptor locations in the air quality assessment. These are included in the receptor list provided in Vol 16 Table 4.4.6.

Operational base case

4.4.21 Base case conditions have been assumed to be the same as baseline conditions with respect to background odour concentrations as no change in background odour concentrations is anticipated.

4.4.22 As indicated in para. 4.3.13, the base case for the odour assessment takes into account the proposed developments at Hampton House, Eastbury House, Riverwalk House, 1-9 Bondway/4-6 South Lambeth Place, St Georges Wharf (Vauxhall Tower), Vauxhall Square Cap Gemini, Market Towers, Island Site Vauxhall Gyratory and 2-14 Tinworth Street/108-110 Vauxhall Walk, including them as receptor locations in the odour assessment. These are included in the receptor list provided in Vol 16 Table 4.4.6.

4.5 Construction effects assessment

Local air quality assessment

4.5.1 Construction effects on local air quality (comprising emissions from construction road traffic, tugs for river barges and construction plant) have been assessed following the modelling methodology set out in Vol 2. This involves predicting NO_2 and PM_{10} concentrations in the baseline year (2010), and in the peak construction year (Site Year 1 of construction), without the proposed development (base case) and with the proposed development (development case). Predicted pollutant concentrations for the base case and development case can then be compared to determine the air quality impacts associated with the project and considering these in the context of statutory air quality objectives/limit values to determine the significance of effects at specified receptors (listed in Vol 16 Table 4.4.6).

4.5.2 The assessment has focussed on NO_2 and PM_{10} concentrations as these are the only pollutants whose air quality standards may be exceeded. From professional experience, emissions of other pollutants (eg, volatile organic compounds (VOCs)) are very unlikely to be significant and therefore do not need to be assessed.

4.5.3 A model verification exercise has been undertaken at the Albert Embankment Foreshore site in line with the Defra guidance LAQM.TG(09)9. This checks the model performance against measured concentrations, using six monitoring sites established for this assessment (AEFM1 – AEFM5 and HEAM1) – see Vol 16 Table 4.4.3) and one local authority monitoring site (LB5) – see Vol 16 Table 4.4.1. Further details regarding the verification process have been included in Vol 16 Appendix B.1. The model adjustment factor derived from the verification process was applied to all model results (for both NO_2 and PM_{10}).

4.5.4 The model inputs for the local air quality assessment for the Albert Embankment Foreshore site are also detailed in Vol 16 Appendix B (B2, B3 and B4). This includes road traffic data (comprising annual average daily traffic flows, heavy good vehicle proportions and speeds for each road link) and data pertaining to the tugs for river barges and construction plant.

NO_2 concentrations

4.5.5 Predicted annual mean NO_2 concentrations for the modelled scenarios are shown in Vol 16 Table 4.5.1. This table details the forecast NO_2 concentrations at specific sensitive receptors. Annual mean results are shown for all of the sensitive receptors but the receptors are divided into two groups depending on whether the annual mean objective/limit value applies or not. The annual mean criteria only apply at those receptors which could be occupied continually for a year (eg, residential properties). Exceedances of the hourly objective / limit value are inferred from the annual mean concentration. Additionally, contour plots are provided (Vol 16 Figures 4.5.1 to Vol 16 Figure 4.5.3, see separate volume of figures) showing modelled concentrations for the baseline, base case and development case scenarios over the construction assessment area. A plot showing the change in NO_2 annual mean concentrations between the base and development cases (in the peak construction year) is also presented at Vol 16 Figure 4.5.4 (see separate volume of figures).

4.5.6 The modelled concentrations in Vol 16 Table 4.5.1 show that annual mean NO_2 levels are predicted to decrease between 2010 and the peak construction year with or without the Thames Tideway Tunnel project. This decrease is due to predicted reductions in background concentrations and improved vehicle engine technology. The results for the development case show increases over the base case at all modelled receptors due to the construction works at the Albert Embankment Foreshore site.

4.5.7 Exceedances of the annual mean objective / limit value (40µg/m^3) are predicted for all receptors in all scenarios. In line with LAQM.TG(09)9, modelled concentrations above 60µg/m^3 indicate exceedances of the hourly NO_2 air quality objective. Therefore, exceedances are considered likely at all receptors in the baseline case, at eight receptors in the base case and in the development case.

Vol 16 Table 4.5.1 Air quality – predicted annual mean NO_2 concentrations

Receptor	Predicted annual mean NO_2 concentration (µg/m^3)			Change between base and dev cases (µg/m^3)	Magnitude of impact
	2010 baseline	Peak construction year base case	Peak construction year dev case		
Receptors where the annual mean objective / limit value applies					
Bridge House residential (AEFR11)	**75.9**	**63.4**	**64.1**	0.6	Small
Peninsula Heights residential (AEFR5)	**63.1**	**50.9**	**51.4**	0.5	Small

Receptor	Predicted annual mean NO_2 concentration ($\mu g/m^3$)			Change between base and dev cases ($\mu g/m^3$)	Magnitude of impact
	2010 baseline	Peak construction year base case	Peak construction year dev case		
St Georges Wharf (Vauxhall Tower) residential (AEFR12)*	**87.4**	**74.2**	**74.4**	0.1	Negligible
2-14 Tinworth Street/108-110 Vauxhall Walk residential (AEFR6)*	**62.3**	**50.5**	**50.6**	0.1	Negligible
Eastbury House residential (AEFR20)*	**78.5**	**63.7**	**63.8**	0.2	Negligible
Riverwalk House residential (AEFR22)*	**72.7**	**60.6**	**60.6**	0.0	Negligible
1-9 Bondway/4-6 South Lambeth Place residential (AEFR21)*	**79.1**	**66.4**	**66.5**	0.0	Negligible
Glasshouse Walk residential (AEFR17)	**59.5**	**48.3**	**48.4**	0.1	Negligible
Hampton House residential (AEFR1)*	**75.9**	**61.1**	**61.3**	0.2	Negligible
Market Towers residential (AEFR18)*	**98.3**	**84.1**	**84.2**	0.1	Negligible
Receptors where the annual mean objective / limit value does not apply					
Chelsea College of Art and Design (AEFR2)	**67.8**	**55.1**	**55.2**	0.0	Negligible

Receptor	Predicted annual mean NO_2 concentration ($\mu g/m^3$)			Change between base and dev cases ($\mu g/m^3$)	Magnitude of impact
	2010 baseline	Peak construction year base case	Peak construction year dev case		
Park Plaza Riverbank London (AEFR15)	**65.5**	**52.9**	**52.9**	0.1	Negligible
Camelford House (AEFR8)	**64.3**	**52.3**	**53.8**	1.4	Small
Tintagel House (AEFR7)	**64.0**	**52.0**	**52.7**	0.7	Small
Vauxhall Cross (AEFR10)	**64.7**	**53.1**	**54.2**	1.1	Small
River Thames (AEFR14)	**61.6**	**50.1**	**50.4**	0.2	Negligible
Albert Embankment Gardens (AEFR3)	**64.5**	**52.0**	**52.2**	0.2	Negligible
Thames Path (AEFR4)	**63.8**	**51.5**	**51.7**	0.2	Negligible
Spring Gardens (AEFR9)	**64.4**	**52.5**	**52.7**	0.2	Negligible
Vauxhall Bus Station (AEFR16)	**116.9**	**101.5**	**101.7**	0.1	Negligible

*Note: Emboldened figures indicate an exceedance of the criteria which is 40µg/m^3 for the annual mean. * Denotes receptor that is altered or constructed after the baseline year. Changes in concentration at each receptor have been rounded to one decimal place.*

4.5.8 The highest predicted increase in annual mean concentration as a result of the construction works at the Albert Embankment Foreshore site is 1.5µg/m^3 which is predicted at Camelford House (AEFR8). However, the annual mean objective / limit value (40µg/m^3) does not apply at this receptor. The largest increase at a receptor of relevant exposure to the annual mean concentration is 0.7µg/m^3 at the residential properties at Bridge House (AEFR11). This increase is described as small magnitude according to the criteria detailed in Vol 2.

4.5.9 The significance of the effect at residential properties at Bridge House (AEFR11) and Peninsula Heights (AEFR5), which have a high sensitivity to local air quality, is **minor adverse** (according to the criteria detailed in Vol 2). The significance of effects would also be **minor adverse** at the

Vauxhall Cross building (AEFR10), which has a low sensitivity to local air quality and at which the hourly objective / limit value applies. The significance of the effects at all other receptors would be **negligible**.

PM_{10} concentrations

4.5.10 Predicted annual mean PM_{10} concentrations for the modelled scenarios are shown in Vol 16 Table 4.5.2. This table details the forecast PM_{10} concentrations at specific sensitive receptors. Additionally, contour plots are provided (Vol 16 Figures 4.5.5 to Vol 16 Figure 4.5.7, see separate volume of figures) showing modelled concentrations for the baseline, base case and development case scenarios over the construction assessment area. A plot showing the change in annual mean PM_{10} concentrations between the base and development cases (in the peak construction year) is also presented at Vol 16 Figure 4.5.8 (see separate volume of figures).

4.5.11 The modelled concentrations in Vol 16 Table 4.5.2 show that annual mean concentrations of PM_{10} are predicted to achieve the annual mean objective / limit value (40µg/m^3) and decrease between 2010 and the peak construction year with or without the Thames Tideway Tunnel project. This decrease is due to predicted reductions in background concentrations and improved vehicle engine technology. The predicted results for the development case show increases over the base case at all modelled receptors due to construction activities at the Albert Embankment Foreshore site.

Vol 16 Table 4.5.2 Air quality – predicted annual mean PM_{10} concentrations

Receptor	Predicted annual mean PM_{10} concentration (µg/m^3)			Change between base and dev cases (µg/m^3)	Magnitude of impact
	2010 baseline	Peak construction year base case	Peak construction year dev case		
Receptors where the annual mean objective / limit value applies					
Bridge House residential (AEFR11)	27.7	25.0	25.1	0.1	Negligible
Peninsula Heights residential (AEFR5)	25.6	23.6	23.6	0.1	Negligible
St Georges Wharf (Vauxhall Tower) residential (AEFR12)*	30.2	26.6	26.7	0.0	Negligible

Receptor	Predicted annual mean PM_{10} concentration ($\mu g/m^3$)			Change between base and dev cases ($\mu g/m^3$)	Magnitude of impact
	2010 baseline	Peak construction year base case	Peak construction year dev case		
2-14 Tinworth Street/108-110 Vauxhall Walk residential (AEFR6)*	25.5	23.4	23.4	0.0	Negligible
Eastbury House residential (AEFR20)*	30.0	27.5	27.5	0.0	Negligible
Riverwalk House residential (AEFR22)*	27.2	24.6	24.6	0.0	Negligible
1-9 Bondway/4-6 South Lambeth Place residential (AEFR21)*	28.3	25.4	25.4	0.0	Negligible
Glasshouse Walk residential (AEFR17)	24.8	22.9	22.9	0.0	Negligible
Hampton House residential (AEFR1)*	29.3	26.9	26.9	0.0	Negligible
Market Towers residential (AEFR18)*	31.8	27.5	27.6	0.0	Negligible
Receptors where the annual mean objective / limit value does not apply					
Chelsea College of Art and Design (AEFR2)	26.8	24.7	24.7	0.0	Negligible
Park Plaza Riverbank London (AEFR15)	26.4	24.3	24.3	0.0	Negligible

Receptor	Predicted annual mean PM_{10} concentration ($\mu g/m^3$)			Change between base and dev cases ($\mu g/m^3$)	Magnitude of impact
	2010 baseline	Peak construction year base case	Peak construction year dev case		
Camelford House (AEFR8)	25.7	23.6	23.8	0.3	Negligible
Tintagel House (AEFR7)	25.8	23.7	23.8	0.1	Negligible
Vauxhall Cross (AEFR10)	25.7	23.5	23.7	0.2	Negligible
River Thames (AEFR14)	25.1	23.1	23.1	0.0	Negligible
Albert Embankment Gardens (AEFR3)	26.0	23.9	24.0	0.0	Negligible
Thames Path (AEFR4)	25.9	23.8	23.8	0.1	Negligible
Spring Gardens (AEFR9)	25.7	23.5	23.5	0.0	Negligible
Vauxhall Bus Station (AEFR16)	37.4	31.7	31.7	0.0	Negligible

** Denotes receptor that is altered or constructed after the baseline year. Changes in concentration at each receptor have been rounded to one decimal place.*

4.5.12 The largest predicted increase in the annual mean concentration as a result of construction at the Albert Embankment Foreshore site is $0.3\mu g/m^3$, predicted at Camelford House (AEFR8). The largest increase at a receptor of relevant exposure to the annual mean concentration is $0.1\mu g/m^3$ at the residential properties at Bridge House (AEFR11) and Peninsula Heights (AEFR5). This change is described as negligible according to the criteria detailed in Vol 2.

4.5.13 With no exceedances of the annual mean PM_{10} standard ($40\mu g/m^3$), the significance of the effects is **negligible** at all receptors.

4.5.14 With regard to the daily mean PM_{10} concentrations, Vol 16 Table 4.5.3 shows the predicted number exceedances of the daily PM_{10} standard ($50\mu g/m^3$) for each modelled scenario. The objective / limit value allows no more than 35 exceedances in a year.

Vol 16 Table 4.5.3 Air quality – predicted number of exceedances of the daily PM_{10} standard

Receptor	Predicted number of exceedances of the daily PM_{10} standard			Change between base and dev cases (days)	Magnitude of impact
	2010 baseline	Peak construction year base case	Peak construction year dev case		
Receptors where the objective / limit value does apply					
Bridge House residential (AEFR11)	20	12	13	0	Negligible
Peninsula Heights residential (AEFR5)	14	9	9	0	Negligible
St Georges Wharf (Vauxhall Tower) residential (AEFR12)*	28	17	17	0	Negligible
2-14 Tinworth Street/108-110 Vauxhall Walk residential (AEFR6)*	13	9	9	0	Negligible
Eastbury House residential (AEFR20)*	27	19	19	0	Negligible
Riverwalk House residential (AEFR22)*	18	12	12	0	Negligible
1-9 Bondway/4-6 South Lambeth Place residential (AEFR21)*	22	13	13	0	Negligible
Glasshouse Walk residential (AEFR17)	12	8	8	0	Negligible

Receptor	Predicted number of exceedances of the daily PM_{10} standard			Change between base and	Magnitude of impact
Hampton House residential (AEFR1)*	25	17	17	0	Negligible
Market Towers residential (AEFR18)*	35	19	19	0	Negligible
Chelsea College of Art and Design (AEFR2)	17	12	12	0	Negligible
Park Plaza Riverbank London (AEFR15)	16	11	11	0	Negligible
Receptors where the objective / limit value does not apply					
Camelford House (AEFR8)	14	9	10	1	Small
Tintagel House (AEFR7)	14	9	10	0	Negligible
Vauxhall Cross (AEFR10)	14	9	10	0	Negligible
River Thames (AEFR14)	13	8	8	0	Negligible
Albert Embankment Gardens (AEFR3)	15	10	10	0	Negligible
Thames Path (AEFR4)	15	10	10	0	Negligible
Spring Gardens (AEFR9)	14	9	9	0	Negligible
Vauxhall Bus Station (AEFR16)	**63**	34	34	0	Negligible

** Denotes receptor that is altered or constructed after the baseline year. Changes in concentration at each receptor have been rounded to the nearest whole number. Emboldened figures indicate an exceedance of the criteria (objective / limit value) which is more than 35 exceedances per year.*

4.5.15 The results in Vol 16 Table 4.5.3 show that the number of daily exceedances of PM_{10} is predicted to decrease between 2010 and the peak construction year with or without the Thames Tideway Tunnel project. This decrease is due to predicted reductions in background concentrations and improved vehicle engine technology. The predicted results for the development case show a maximum increase of one day with concentrations above 50µg/m^3 compared with the base case at the modelled receptors due to construction works at the Albert Embankment Foreshore site. No increase in the number of days per year with PM_{10} concentrations above 50µg/m^3 is predicted at a receptor of relevant exposure to the daily mean air quality objective / EU limit value.

4.5.16 With no exceedances of the daily PM_{10} criteria in the development case, the significance of the effects would be **negligible** at all sensitive receptors.

Sensitivity test for programme delay

4.5.17 For the assessment of local air quality effects during construction, a delay to the Thames Tideway Tunnel project of approximately one year would not be likely to materially change the assessment findings reported above for the existing and proposed receptors. Based on the development schedule (Vol 16 Appendix N), it is possible that as a result of the one year delay, part of the Vauxhall Square Cap Gemini and Island Site Vauxhall Gyratory developments may be complete and occupied. However, it is not expected that any new receptors would experience different effects to those receptors assessed above, rather it would be a case of the potential for some additional receptors to experience the same as those that have already been identified.

Construction dust

4.5.18 Construction dust would be generated from both on-site activities and from road vehicles accessing and servicing the site.

4.5.19 Dust sensitive receptors have been identified in the vicinity of the Albert Embankment Foreshore site in accordance with the criteria in Vol 2, as described in Vol 16 Table 4.4.6. A summary of the approximate numbers of receptors in distance bands from the Albert Embankment Foreshore site is listed in Vol 16 Table 4.5.4.

Vol 16 Table 4.5.4 Air quality – numbers of dust sensitive receptors

Buffer distance (m)	Number of receptors*	Receptor type
<20	10-100	Residential, open space and offices
20-50	10-100	Residential and offices
50-100	100-500	Residential, offices and open space
100-350	>500	Residential, offices, and open space

** Buildings or locations that could be affected by nuisance dust.*

4.5.20 In line with the IAQM guidance (Institute of Air Quality Management, 2012)[10], the site has been categorised using the criteria given in Vol 2 to assess the likely impacts from demolition, earthworks, construction and trackout activities during construction and the likely effects of these activities on sensitive receptors close to the development.

4.5.21 The demolition for the Albert Embankment Foreshore site is classified as a 'small' dust emission class. This classification is based on the small size of the demolition volumes, which is considerably less than 20,000m^3. As the nearest receptor is within 20m of the construction site, this makes the risk category for demolition activities medium risk.

4.5.22 The earthworks have been assessed to be a 'high' dust emission class as the size of the construction site is between 2,500m^2 and 10,000m^2 and the total material to be moved is more than 100,000 tonnes. With the nearest receptor within 20m, the site is assessed to be high risk for earthworks.

4.5.23 The construction proposed for the Albert Embankment Foreshore site has a 'medium' dust emission class. This classification is based on the quantity of concrete that would be used and batched on-site. The risk category for construction activities is therefore assessed to be of high risk due to receptors being within 20m.

4.5.24 There would be 50-100m of unpaved haul roads on site and the number of construction lorries per day would be between 25-100, so the trackout dust emission class is classified as 'medium'. The closest receptor is within 20m of the affected roads. The risk category from trackout is therefore assessed to be medium risk.

4.5.25 The risk categories for the four activities are summarised in Vol 16 Table 4.5.5. This summary of these risks does not take into account the measures outlined in the *CoCP (Parts A and B)*.

Vol 16 Table 4.5.5 Air quality – summary of construction dust risks

Source	Dust soiling / PM_{10} effects
Demolition	Medium risk site
Earthworks	High risk site
Construction	High risk site
Trackout	Medium risk site

Note: without CoCP measures

4.5.26 On this basis, the development at the Albert Embankment Foreshore site is classified as a high risk site overall.

4.5.27 Although the receptor sensitivity (with respect to construction dust nuisance) is identified as medium for all receptors apart from the Thames Path and the River Thames (as identified in Vol 16 Table 4.4.6), due to the duration of the works, the other developments being constructed in the area and the high PM_{10} background concentrations in the locality, the sensitivity of the area has been defined as 'very high' overall.

4.5.28 With regard to the significance of effects, a high risk site with a very high sensitivity of the area would result in a major adverse effect without mitigation. When the measures outlined in the *CoCP* are applied, the significance of the effect would be reduced to **minor adverse** (in accordance with IAQM guidance). This significance relates to receptors within 50m of the construction area. For receptors at distances greater than 50m from the construction are, the significance of the effect is **negligible**. The significance of the effect for each receptor is summarised Vol 16 Table 4.5.6.

Vol 16 Table 4.5.6 Air quality – significance of construction dust effects

Receptor	Significance of effect
Bridge House residential (AEFR11)	Minor adverse
Peninsula Heights residential (AEFR5)	Minor adverse
St Georges Wharf (Vauxhall Tower) residential (AEFR12)*	Negligible
2-14 Tinworth Street/108-110 Vauxhall Walk (AEFR6) residential *	Negligible
Eastbury House residential (AEFR20)*	Negligible
Riverwalk House residential (AEFR22)*	Negligible
1-9 Bondway and 4-6 South Lambeth Place residential (AEFR21)*	Negligible
Glasshouse Walk residential (AEFR17)	Negligible
Hampton House residential (AEFR1)*	Negligible
Market Towers residential (AEFR18)*	Negligible
Chelsea College of Art and Design (AEFR2)	Negligible
Park Plaza Riverbank London (AEFR15)	Negligible
Camelford House (AEFR8)	Minor adverse
Tintagel House (AEFR7)	Minor adverse
Vauxhall Cross (AEFR10)	Minor adverse
River Thames (AEFR14)	Negligible
Albert Embankment Gardens (AEFR3)	Negligible
Thames Path (AEFR4)	Negligible
Spring Gardens (AEFR9)	Negligible
Vauxhall Bus Station (AEFR16)	Negligible

** Denotes receptor that is altered or constructed after the baseline year.*

4.5.29 If the alternative access route, Option B, proposed between Camelford House and Tintagel House, were to be used, it would not affect the construction effects identified above due to the low number of construction vehicles that would use the access road.

4.6 Operational effects assessment

4.6.1 The operational assessment has been undertaken in accordance with the modelling methodology set out in Vol 2. Vol 16 Table 4.6.1 shows the predicted maximum ground level odour concentrations at the Albert Embankment Foreshore site. These are the highest concentrations that could occur at the worst affected ground level receptor at or near the site in a typical year. In accordance with the odour benchmark set by the Environment Agency (EA), results are presented for the 98th percentile of hourly average concentrations in the year (or the 176th highest hourly concentration in the year) and the number of hours in a year with concentrations above 1.5ou_E/m^3. Achieving the 98th percentile is considered to prevent nuisance and protect amenity. The number of hours with concentrations above 1.5ou_E/m^3 gives an indication of the number of hours in a year that an odour might be detectable at the worst affected receptor. The Environment Agency benchmark permits 175 hours above 1.5ou_E/m^3. The table also identifies the magnitude of the identified impacts in accordance with the criteria detailed in Vol 2.

Vol 16 Table 4.6.1 Odour – impacts and magnitude – operation

Year	Maximum at ground level locations		Impact magnitude and justification
Typical	98th percentile (ou_E/m^3)	0	Negligible 98th percentile concentration is less than 1ou_E/m^3
	No. of hours > 1.5ou_E/m^3	2	

4.6.2 In Vol 16 Table 4.6.1 above, the 98th percentile is shown as zero as air would be released from the ventilation column for less than 2% (176 hours) of the year. This means that the odour benchmark would be achieved at all locations. This represents an impact of negligible magnitude.

4.6.3 The highest odour concentrations would occur within 10m of the ventilation column with concentrations reducing rapidly away from this area. There would be a maximum of two hours in a year with an odour concentration greater than 1.5ou_E/m^3 so there could be a detectable odour on an hourly basis within 10m of the ventilation column. Odour would not be detectable at any buildings on an hourly basis. With a frequent use year (ie, a more rainy year than average), the situation would be similar.

4.6.4 With regard to the significance of effects given that the predicted odour concentrations at all locations would not exceed the 98th percentile benchmark of $1.5ou_E/m^3$, it is considered that overall significance would be **negligible**. No significant effects are therefore predicted in relation to odour.

4.7 Cumulative effects assessment

Construction effects

4.7.1 Two developments were identified in Section 4.3 (Vauxhall Square Cap Gemini and Island Site Vauxhall Gyratory) that could potentially give rise to cumulative effects as they would be under construction as the same time as the proposed development at the Albert Embankment Foreshore site. This cumulative effect has been taken into account by increasing the sensitivity of the area to construction dust. The traffic effects from these developments have already been accounted for in the traffic data used for the air quality assessment. Therefore the effects on local air quality would remain as described in Section 4.7 above.

4.7.2 In the event that the programme for the Thames Tideway Tunnel is delayed by approximately one year, part of the Vauxhall Square Cap Gemini and Island Site Vauxhall Gyratory developments may be built and occupied which would lead to a corresponding reduced level of cumulative activity. Cumulative effects would therefore be no greater than described above.

Operational effects

4.7.3 As described in Section 4.3, there would not be any cumulative operational effects. Therefore the effects on air quality would remain as described in Section 4.6 above.

4.8 Mitigation

Construction

4.8.1 Control measures of relevance to air quality are embedded in the *CoCP* as summarised in Section 4.2. No mitigation is required because effects are not significant.

Operation

4.8.2 Based on the assessment results (which includes the environmental design measures detailed in para. 4.2.17), no mitigation is required because effects are not significant.

Monitoring

4.8.3 It is envisaged that an appropriate particulate monitoring regime would be agreed with the LB of Lambeth prior to commencement of construction at the Albert Embankment Foreshore site.

4.9 Residual effects assessment

Construction effects

4.9.1 As no mitigation measures are required, the residual construction effects remain as described in Section 4.5. All residual effects are presented in Section 4.10.

Operational effects

4.9.2 As no mitigation measures are required, the residual operational effects remain as described in Section 4.6. All residual effects are presented in Section 4.10.

4.10 Assessment summary

Vol 16 Table 4.10.1 Air quality – summary of construction assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Residential – Bridge House (AEFR11)	Local air quality – effects from construction road traffic, tugs for river barges and plant emissions	Minor adverse	None	Minor adverse
	Effects from construction dust	Minor adverse	None	Minor adverse
Residential – Peninsula Heights (AEFR5)	Local air quality – effects from construction road traffic, tugs for river barges and plant emissions	Minor adverse	None	Minor adverse
	Effects from construction dust	Minor adverse	None	Minor adverse
Residential – St Georges Wharf (Vauxhall Tower) (AEFR12)*	Local air quality – effects from construction road traffic, tugs for river barges and plant emissions	Negligible	None	Negligible
	Effects from construction dust	Negligible	None	Negligible
Residential – 2-14 Tinworth Street/108-110 Vauxhall Walk (AEFR6)*	Local air quality – effects from construction road traffic, tugs for river barges and plant emissions	Negligible	None	Negligible
	Effects from construction dust	Negligible	None	Negligible
Residential - Eastbury House (AEFR20)*	Local air quality – effects from construction road traffic, tugs for river barges and plant emissions	Negligible	None	Negligible
	Effects from construction dust	Negligible	None	Negligible
Residential - Riverwalk	Local air quality – effects from construction	Negligible	None	Negligible

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
House (AEFR22)*	road traffic, tugs for river barges and plant emissions			
	Effects from construction dust	Negligible	None	Negligible
Residential - 1-9 Bondway/4-6 South Lambeth Place (AEFR21)*	Local air quality – effects from construction road traffic, tugs for river barges and plant emissions	Negligible	None	Negligible
	Effects from construction dust	Negligible	None	Negligible
Residential - Hampton House (AEFR1)*	Local air quality – effects from construction road traffic, tugs for river barges and plant emissions	Negligible	None	Negligible
	Effects from construction dust	Negligible	None	Negligible
Residential - Glasshouse Walk (AEFR17)	Local air quality – effects from construction road traffic, tugs for river barges and plant emissions	Negligible	None	Negligible
	Effects from construction dust	Negligible	None	Negligible
Residential – Market Towers (AEFR18)*	Local air quality – effects from construction road traffic, tugs for river barges and plant emissions	Negligible	None	Negligible
	Effects from construction dust	Negligible	None	Negligible
Educational - Chelsea College of Art and Design (AEFR2)	Local air quality – effects from construction road traffic, tugs for river barges and plant emissions	Negligible	None	Negligible
	Effects from construction dust	Negligible	None	Negligible
Offices - Camelford	Local air quality – effects from construction	Negligible	None	Negligible

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
House (AEFR8)	road traffic, tugs for river barges and plant emissions			
	Effects from construction dust	Minor adverse	None	Minor adverse
Offices - Tintagel House (AEFR7)	Local air quality – effects from construction road traffic, tugs for river barges and plant emissions	Negligible	None	Negligible
	Effects from construction dust	Minor adverse	None	Minor adverse
Offices - Vauxhall Cross (AEFR10)	Local air quality – effects from construction road traffic, tugs for river barges and plant emissions	Minor adverse	None	Minor adverse
	Effects from construction dust	Minor adverse	None	Minor adverse
Recreational - Albert Embankment Gardens (AEFR3)	Local air quality – effects from construction road traffic, tugs for river barges and plant emissions	Negligible	None	Negligible
	Effects from construction dust	Negligible	None	Negligible
Recreational - Spring Gardens (AEFR9)	Local air quality – effects from construction road traffic, tugs for river barges and plant emissions	Negligible	None	Negligible
	Effects from construction dust	Negligible	None	Negligible
Recreational - Thames Path (AEFR4)	Local air quality – effects from construction road traffic, tugs for river barges and plant emissions	Negligible	None	Negligible
	Effects from construction dust	Negligible	None	Negligible
Recreational – River	Local air quality – effects from construction	Negligible	None	Negligible

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Thames (AEFR14)	road traffic, tugs for river barges and plant emissions			
	Effects from construction dust	Negligible	None	Negligible
Hotel - Park Plaza Riverbank London (AEFR15)	Local air quality – effects from construction road traffic, tugs for river barges and plant emissions	Negligible	None	Negligible
	Effects from construction dust	Negligible	None	Negligible
Commercial - Vauxhall Bus Station (AEFR16)	Local air quality – effects from construction road traffic, tugs for river barges and plant emissions	Negligible	None	Negligible
	Effects from construction dust	Negligible	None	Negligible

** Denotes receptor that is altered or constructed after the baseline year.*

Vol 16 Table 4.10.2 Odour – summary of operational assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Residential – Bridge House (AEFR11)	Odour	Negligible	None	Negligible
Residential – Peninsula Heights (AEFR5)		Negligible	None	Negligible
Residential – St Georges Wharf (Vauxhall Tower) (AEFR12)*		Negligible	None	Negligible
Residential – 2-14 Tinworth Street/108-110 Vauxhall Walk (AEFR6)*		Negligible	None	Negligible
Residential – Eastbury House (AEFR20)*		Negligible	None	Negligible
Residential – Riverwalk House (AEFR22)*		Negligible	None	Negligible
Residential – 1-9 Bondway/4-6 South Lambeth Place (AEFR21)*		Negligible	None	Negligible
Residential - Glasshouse Walk (AEFR17)		Negligible	None	Negligible
Residential - Hampton House (AEFR1)*		Negligible	None	Negligible
Residential – Vauxhall Square Cap Gemini Site (AEFR13)*		Negligible	None	Negligible
Residential – Market Towers (AEFR18)*		Negligible	None	Negligible
Residential – Island Site Vauxhall Gyratory (AEFR19)*		Negligible	None	Negligible
Educational - Chelsea College of Art and Design (AEFR2)		Negligible	None	Negligible
Hotel - Park Plaza Riverbank London (AEFR15)		Negligible	None	Negligible
Offices - Camelford House (AEFR8)		Negligible	None	Negligible
Offices - Tintagel House (AEFR7)		Negligible	None	Negligible
Offices - Vauxhall Cross (AEFR10)		Negligible	None	Negligible
Recreational – River Thames (AEFR14)		Negligible	None	Negligible

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Recreational - Albert Embankment Gardens (AEFR3)		Negligible	None	Negligible
Recreational - Thames Path (AEFR4)		Negligible	None	Negligible
Recreational - Spring Gardens (AEFR9)		Negligible	None	Negligible
Commercial - Vauxhall Bus Station (AEFR16)		Negligible	None	Negligible

** Denotes receptor that is altered or constructed after the baseline year.*

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.16**

Volume 16: Albert Embankment Foreshore site assessment

Section 5: Ecology - aquatic

APFP Regulations 2009: Regulation **5(2)(a)**

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Creating a cleaner, healthier River Thames

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Thames Tideway Tunnel

Environmental Statement

Volume 16: Albert Embankment Foreshore site assessment

Section 5: Ecology – aquatic

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5 Ecology – aquatic

5.1 Introduction

5.1.1 This section presents the findings of the assessment of the likely significant effects of the proposed development on aquatic ecology at the Albert Embankment Foreshore site.

5.1.2 The proposed development may lead to effects on aquatic ecology due to both the physical works in-river during construction and operation of the Thames Tideway Tunnel project. During operation the interception of the combined sewer overflow (CSO) would result in substantially reduced discharges of untreated sewage into the tidal reaches of the River Thames (tidal Thames) at this location. There would also be permanent in-river structures at this site. Significant construction and operational effects are therefore considered likely, and an assessment of effects on aquatic ecology for both phases is presented.

5.1.3 The presence of sewage in the aquatic environment has adverse effects on aquatic ecology receptors (habitats, mammals, fish, invertebrates and algae). In particular, discharges of untreated sewage effluent can result in low levels of dissolved oxygen (DO), which can cause mass fish mortalities known as hypoxia events. There are CSOs discharging at locations throughout the tidal Thames, including the reach upstream and downstream of the Brixton Storm Relief and Clapham Storm Relief CSOs.

5.1.4 The tidal Thames comprises a dynamic environment, in which tidal action leads to dispersal of discharges. Therefore the effects of the operational Thames Tideway Tunnel project, which is designed to intercept the most problematic CSOs, would be most evident at a project-wide level. These effects are therefore reported in Volume 3 Project-wide effects assessment. This section assesses the localised effects at a site-specific level for the Albert Embankment Foreshore site.

5.1.5 The assessment of the likely significant effects of the project on aquatic ecology has considered the requirements of the *National Policy Statement (NPS) for Waste Water*[1]. In line with these requirements, designations, species and habitats relevant to aquatic ecology are identified and measures incorporated into the proposed development described. Based on assessment findings, measures to address likely significant adverse effects are identified. Vol 2 Section 5 provides further details on the methodology.

5.1.6 Plans of the proposed development as well as figures included in the assessment for this site are contained in a separate volume (Volume 16 Albert Embankment Foreshore Figures).

5.2 Proposed development relevant to aquatic ecology

5.2.1 The proposed development is described in Section 3 of this volume. The elements of the proposed development relevant to aquatic ecology are set out below.

Construction

5.2.2 The construction maximum extent of working at Albert Embankment Foreshore would be located predominantly on the foreshore. Construction activities would occur over three and a half years, with structures in place for approximately three years. Two access options have been considered, via Lack's Dock or between Camelford House and Tintagel House, but both involve routes above the high water mark and the two routes would have the same impact/effect on aquatic ecology. A separate impact assessment of the two options has therefore not been undertaken. The key elements of the construction of the proposed development of relevance to aquatic ecology would be as follows:

a. The installation of temporary and permanent sheet piling to create a cofferdam on the foreshore for the CSO interception works as shown in the Construction Phases – Phase 1 Site Setup, Shaft Construction and Tunnelling drawing and Construction Phases – Phase 2 Construction of other Structures drawing, and subsequent removal of the temporary cofferdams. The installation of cofferdams would be accomplished using a jack-barge or similar equipment.

b. It is assumed for the assessment that the majority of foreshore material within the temporary cofferdams would remain in situ. For structural reasons, soft material located adjacent to the perimeter of the temporary cofferdams and adjacent to the river wall would be removed. The soft material includes silt, peat and other materials. Removal of this material would ensure that any settlement of the cofferdam fill material does not adversely affect the ties between the walls of the twin walled temporary cofferdam leading to structural difficulties. All soft material within permanent cofferdams would be removed to ensure sound foundations for permanent construction.

c. The exact extent and depth of the foreshore deposits to be removed at each site would be informed by geotechnical investigations. Areas of removed material would be filled with gravel similar to the existing bed material. Cofferdam fill material would then be placed onto the foreshore on top of a geotextile layer. Suitable sized plant would be utilised to reduce potential load impacts on the foreshore. Upon removal of the temporary cofferdam, the fill and geotextile layer would be removed and the bed would be reinstated to match the existing river bed conditions. Material excavated would be disposed of in accordance with the project's Waste Management procedure.

d. The placement and removal of a temporary concrete campshed of approximately 400m^2 on the foreshore outside the cofferdams, suitable for up to a 350t barge

e. Regular barge movements and resting on the campshed (approximately eight barge movements per day at the peak)

f. Temporary construction access for use by low-ground-bearing machines along the foreshore at low tide between the two sets of temporary cofferdams

g. a slight realignment of the concrete block foreshore slipway in Lacks Dock

h. Five steel monopile dolphins (in-river structures) would be constructed upstream of the permanent structure to protect against impacts from river vessels.

5.2.3 The construction of in-river structures, and in particular the temporary works cofferdams would affect the river regime. There is potential for localised increases in flow velocity to cause scour of the river bed and foreshore, or deposition of sediments. The scour could occur around the face of the cofferdam or at the adjacent bridge supports (abutment scour) or across the channel width (contraction scour). Any potential scour development during construction would be monitored and if relevant trigger levels are reached, appropriate protection measures would be provided. Further details are provided in Scour monitoring and mitigation strategy (Vol 3 Appendix L.4).

Code of Construction Practice

5.2.4 The *Code of Construction Practice* (*CoCP*)[i] context sets out the standards, procedures, and measures for managing and reducing construction effects. These measures would be implemented through a *Construction environment management plan* (*CEMP*) prepared by the contractor to control site operations and works.

5.2.5 The *CoCP Part A* includes the following measures, which are an integral part of the project and relevant for the purposes of this assessment:

a. The location of barges resting on the foreshore and river bed shall be controlled to reduce extent of potential environmental impacts. The design of facilities such as campsheds would consider the need to minimise environmental impacts and should consider the use of lattice structure barge grids where appropriate. In-river structures, including campsheds, would be removed on completion of the works unless otherwise agreed. Where concrete is used, such as campsheds, a membrane is required to protect the underlying riverbed. The method for reinstatement of the temporary works area would be subject to a method statement that would consider requirements for impact on aquatic ecology (*CoCP Part A* Section 11).

b. Avoiding piling at night to ensure free windows of opportunity to allow fish to migrate past the site within each 24-hour period (*CoCP Part A* Section 6).

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[i] The *Code of Construction Practice (CoCP)* is provided in Vol 1 Appendix A. It contains general requirements (Part A), and site specific requirements for this site (Part B).

c. Undertaking noise measurements at prescribed points and intervals to ensure compliance with the *CoCP* (*CoCP Part A* Section 6).

d. Limiting allowable noise and vibration levels to leave part of the river cross-section passable at all times (*CoCP Part A* Section 6).

e. Where technically feasible, utilising low noise/vibration cofferdam or pile/pier installation techniques such as pressing or vibro-piling rather than impact/percussive piling. In the event that in-river percussive piling is needed, prior approval from the EA would be required (*CoCP Part A* Section 6).

f. Where vibro-piling is undertaken, slowly increasing the power of the driving to enable fish to swim away to leave the area before the full power of the pile driver is felt through the river (*CoCP Part A* Section 6).

g. The contractor shall make every reasonable effort to remove all piles completely from the bed of the river. With the prior written agreement of the PLA the contractor would ensure any piles which prove impossible to fully extract on application of the confirmed minimum crane pull of 40 tonnes, are driven down, cut off or removed to a depth of a least 1 metre below the adjacent riverbed level unless advised otherwise (*CoCP Part A* Section 4).

h. Dewatering operations for cofferdams and in river structures need to consider fish rescue arrangements. To the extent that it is not dealt with in the D application for development consent, prior written consent from the EA is required under the Salmon and Freshwater Fisheries Act, 1975, to net or trap fish, or introduce fish into a water course (*CoCP Part A* Section 8).

i. Avoidance of pollution of the river through measures that accord with the principles set out in industry guidelines, including the Environment Agency (EA) note PPG05 *Works in, near or liable to affect water courses* (Environment Agency, undated)[2] and Construction Industry Research and Information Association (CIRIA) report *C532: Control of water pollution from construction sites* (CIRIA, 2001)[3] (*CoCP Part A* Section 8).

j. Appropriate measures would be taken with regard to ‘in river’ works to minimise the release of suspended sediment and solids into the water column (*CoCP Part A* Section 8).

k. For works where materials are being loaded and unloaded on the river, the Contractor is required to establish suitable management arrangements and mitigation measures so as to prevent spillage of transferred materials. This includes design of conveyor systems, enclosures, conveyor belt scrapper locations and selection of other loading equipment. Monitoring methods and contingencies arrangements are to be included in the *River Transport Management Plan and Emergency Preparedness Plan* (*CoCP Part A* Section 4).

l. In constructing temporary cofferdams the contractor would avoid any mixing of fill material with the underlying substrate. This would be achieved by installing a membrane between the existing river bed and the back fill material (*CoCP Part A* Section 11).

m. The lighting, to be specified in a *Lighting management plan*, would be designed to comply with relevant standards. This would consider the aquatic environment and avoid direct lighting of watercourses, where reasonably practical, to avoid inhibiting movements of photophobic species such as eel (*CoCP Part A* Section 4). (See para. 5.2.6 for *CoCP Part B* measures for site working hours relevant to lighting at Albert Embankment Foreshore.)

5.2.6 The *CoCP Part B* includes the following elements specific to the Albert Embankment Foreshore site:

a. A site-specific lighting plan is required. The lighting would address the impact on terrestrial and aquatic ecology and include the use of low level directional lighting where possible whilst meeting safe work requirements (*CoCP Part B* Section 4).

b. Membrane to be installed between existing river bed and temporary back fill material to prevent contamination of juvenile fish habitat. Areas of foreshore used for temporary works would be restored to similar condition and material prior to the works (*CoCP Part B* Section 11).

c. The area of foreshore between working sites would be monitored for spillage of oils, fuels and other materials during use. The *Contractors Environmental Management Plan (CEMP*) would include specific control and mitigation measures at this location (*CoCP Part B* Section 8).

d. The loading and unloading of barges would only be carried out during standard working hours (*CoCP Part B* Section 6).

e. The site would adhere to standard, extended and continuous working hours for the duration of the Clapham/Brixton connection tunnel construction (*CoCP Part B* Section 4).

Operation

5.2.7 The key elements of the operation of the proposed development of relevance to aquatic ecology are set out below. Further information is provided in Section 3 of this volume.

5.2.8 Discharges from the Brixton Storm Relief CSO and Clapham Storm Relief CSO would be intercepted as part of the project. Based on the base case (which includes permitted tidal Thames sewage treatment works upgrades, and the Lee Tunnel scheme, as well as projected population increases) discharges (which have been modelled for 2021) during the Typical Year[ii] from the Brixton Storm Relief CSO are anticipated to be 279,000m^3 per annum over a total of 31 discharge events (or spills) by 2021. The discharge is predicted to reduce to 5,700m^3 per annum over

[ii] The ‘Typical Year’ represents the most ‘typical’ 12 month period of rainfall observed between 1970 and 2011 and is represented by the period from October 1979 to September 1980

one discharge event once the Thames Tideway Tunnel project is operational. Discharges from the Clapham Storm Relief CSO during the Year are anticipated to be 14,000m^3 per annum over a total of 6 discharge events by 2021. The discharge is predicted to reduce to 7,900m^3 per annum over one discharge event once the Thames Tideway Tunnel project is operational. The total residual discharge at this site would thus be 13,600m^3 over two spills. This represents an approximately 95% decrease as a result of the Thames Tideway Tunnel project.

5.2.9 A permanent CSO interception structure would be in place in the river and would give rise to effects the construction phase of the project onwards. However, as it is a permanent structure, its effects would be ongoing for its full existence, and are therefore considered under the operational assessment.

5.2.10 Scour protection for the permanent foreshore interception structure and discharge apron would consist of buried rip-rap which would be overlaid with an appropriate substrate material.

Environmental design measures

5.2.11 Generic design principles of relevance to aquatic ecology at Albert Embankment Foreshore are as follows:

a. Where appropriate to context and practicable, fendering (horizontal or vertical) shall be included on the foreshore structure, preferably in timber, in order to promote aquatic ecology.

b. Scour protection shall be provided beneath any new outfall extending to below the low water line and along the line of the new river wall (to protect its foundation). The detailed design and extent of this shall seek to avoid or minimise adverse effects on aquatic ecology.

c. Light pollution shall be minimised within the sites by using capped, directional and cowled lighting units.

d. Lighting shall balance the need to provide a safe environment with one that also responds to the need to reduce light pollution and promote biodiversity (terrestrial and aquatic).

e. No lighting shall be proposed in the River Thames or directed towards it unless required for navigational purposes.

f. There shall be no lighting on the outside of the foreshore structures unless required for navigational purposes.

5.2.12 Environmental design measures specific to Albert Embankment Foreshore include a series of intertidal terraces that have been designed into the permanent works. The terraces would provide inter-tidal habitat which would be detailed and constructed to minimise the accumulation of litter. Pre-established planting would be used in the terraces. The interception structure would be “bedded” into the foreshore by the use of rocks and boulders in order to provide habitat for fish species.

5.2.13 All of the terraces would be above mean low water springs (i.e. all would be in the intertidal zone). The lower two terraces would be unvegetated and left to accrete with sediment and colonise naturally by invertebrates.

The outer 'walls' of the two lowest terraces would made of boulders (maximum size approximately 500mm diameter) rather than cast concrete, to provide a more diverse habitat for fish. The scour modelling available indicates that there would be negative bed shear in this area which implies that scour should not be a problem and that net deposition of sediment may in fact occur, particularly at the bottom of the profile. The third terrace would be planted with species such as sea aster (*Aster tripolium*), sea clubrush (*Bolboschoenus maritimus),* saltmarsh rush (*Juncus gerardii*), sea plantain (*Plantago maritima*), sea rush (*Juncus maritimus*), reflexed saltmarsh grass (*Puccinellia distans*).

5.2.14 The upper terraces would be inundated less frequently. These are therefore more appropriate for common reed (*Phragmites australis*). The highest terrace would only be inundated on a roughly two-week cycle. The highest terrace would therefore essentially consist of a c.400mm deep standing brackish pool which would be tidally flushed every two weeks.

5.3 Assessment methodology

Engagement

5.3.1 Volume 2 Environmental assessment methodology documents the overall engagement which has been undertaken in preparing the *Environmental Statement*. Stakeholder comments relating to Albert Embankment and the response to them are presented in Vol 16 Table 5.3.1.

Vol 16 Table 5.3.1 Aquatic ecology – stakeholder engagement for Albert Embankment Foreshore

Organisation	Comment	Response
Local authorities – London Borough (LB) of Lambeth	The temporary and permanent cofferdams and other structures in the river (including extending the river wall) would have an impact upon foreshore structure, water flows and sediment deposition (including scour) so these need to be carefully modelled and mitigated.	Findings of the assessment address these issues. Further modelling would be undertaken for the *Environmental Statement*.
	There is a need to ensure the soft landscaping to the new river frontage is maximised and of a design that is easy to maintain, blends in with surrounding landscapes and adds ecological value to the Thames foreshore and Borough. The same applies to the design and construction of new river walls.	An integrated approach to the design of river frontage sites has been adopted which takes account of both the public realm and habitat requirements and opportunities of each site. Detailed mitigation is reported in this assessment.
	There needs to be regular and targeted monitoring as the works begin and progress to assess if any changes	This would be taken into account in the *Environmental Statement*

Organisation	Comment	Response
	in ecology and habitat quality are occurring or any unforeseen impacts are beginning to develop, so allowing for additional or increased mitigation measures to be instituted.	and planning to take account of post-*Environmental Statement* monitoring work.
	The baseline situation will need to be reinforced with field and desk based surveys and modelling exercises to accurately quantify the potential impacts of both construction and operational activities. We would expect these surveys to be undertaken and results fully evaluated before any final designs are presented.	This assessment describes the baseline surveys undertaken relating to fish, habitats and aquatic invertebrates and the desk-study data obtained regarding these groups and mammals/algae.
	The final design and construction of any retained structures in the Thames needs to ensure a range of positive features are incorporated such as wall designs, appropriate planting and profiling to avoid impeded water flow or excessive redistribution of sediments. The walls of the Thames in this location are currently of low ecological value so there are opportunities to create features which address this.	An integrated approach to the design of river frontage sites has been adopted which takes account of both the public realm and habitat requirements and opportunities of each site. Mitigation is reported in this assessment.
	The Council will want comfort right through the process that any impacts upon the SINC will be quantified and minimised.	Habitat losses associated with temporary and permanent landtake are presented in paras. 5.5.2 and 5.6.2. The footprint of the temporary and permanent structures has been minimized through the design process
	The design and profiling of the extended riverside area occupied by the CSO needs to consider what effects there will be on the river itself and whether river and bankside habitat would be affected, or how such designs could offer appropriate mitigation for loss or change in existing habitat. So long as that effect is minimised or creates the same quality of habitat in a slightly different location, then the effect on the SINC can be	The design of the intertidal terraces aims to provide marginal habitats including reedbed which are characteristic of the brackish zone of the River Thames and Tidal Tributaries Site of Importance for Nature Conservation (Grade III of Metropolitan importance).

Organisation	Comment	Response
	kept within reason.	
Environment Agency (Phase 2 consultation response, February 2012)	The *Environmental Statement* should consider if the permanent maintenance trackway over 170m of foreshore needs to be hard engineered or whether vehicles will be able to pass over the natural foreshore. There would be some negative impacts whilst this took place but as maintenance visits are likely to be infrequent, this may be more acceptable in terms of short term impact when compared with the permanent habitat loss of the trackway.	There is no longer a permanent maintenance trackway at this site.
Environment Agency (Section 48 consultation response, October 2012)	Gravel/ Shingle area must be fully reinstated.	Upon removal of the temporary cofferdam, the fill and geotextile layer would be removed and the bed would be reinstated to match the existing river bed conditions.
	Encroachment into the river should be minimised further.	The footprint of the permanent structures has been minimised as far as possible to accommodate the necessary works, therefore further minimisation of encroachment is not possible.

Baseline

5.3.2 The baseline methodology follows the methodology described in Vol 2 Section 5. There are no site specific variations for identifying the baseline conditions for this site.

5.3.3 The assessment is based on survey and desk study data. For habitats, mammals, fish, invertebrates and algae, desk study data has been obtained for the whole of the tidal Thames. The data sets for fish, invertebrates and algae are based on fixed sampling locations at intervals through the tidal Thames. Locations as close to Albert Embankment Foreshore as possible have been selected. Details of the background and data sets are provided in Vol 2 Section 5.

5.3.4 Surveys for fish and invertebrates were undertaken during October 2010 at Albert Embankment Foreshore. During these surveys the intertidal habitats present were recorded. Surveys for juvenile fish were also undertaken at five sampling locations along the tidal Thames six times between May and September 2011, with the closest site surveyed being Chelsea Embankment Foreshore, located 2km upstream of Albert Embankment Foreshore. Surveys for algae were undertaken at eight sampling locations in May 2012, comprising each of the foreshore sites, including Albert Embankment Foreshore. The survey comprised sampling of algae along a vertical transect of the river wall located within or as close to the proposed development site as possible.

Construction

5.3.5 The assessment methodology for the construction phase follows that described in Vol 2 Section 5. The assessment area is the zone which lies within a 100m radius of the boundary of the proposed development site. The assessment year for construction effects is Site Year 1, ie when construction would commence. There are no site specific variations for undertaking the construction assessment of this site.

5.3.6 Section 5.5 details the likely significant effects arising from the construction of the proposed development at the Albert Embankment Foreshore site. The effects of interception of all of the CSOs within the Thames Tideway Tunnel project on aquatic ecology receptors at a river wide level are considered in Vol 3 Section 5.

5.3.7 The development proposed on land at St Georges Wharf , 200m south of the site, includes provision for a riverside walkway, however it is not considered that that this would change the aquatic ecology baseline. All other developments are in-land, do not comprise in-river development, development adjacent to the river or development discharging into the river and therefore would not affect the aquatic ecology baseline. Similarly, there are no schemes listed in the site development schedule (Vol 16 Appendix N) under construction which would be in-river, adjacent to the river or discharging to the river. Thus there are no schemes that could lead to a cumulative impact at Albert Embankment Foreshore. Therefore no cumulative impact assessment has been undertaken.

5.3.8 The assessment of construction effects also considers the extent to which the assessment findings would be likely to be materially different, should the programme for the Thames Tideway Tunnel project be delayed by approximately one year.

Operation

5.3.9 The assessment methodology for the operation phase follows that described in Vol 2 Section 5. The assessment area is as stated in para. 5.3.5. There are two assessment years for operational effects; Year 1 and Year 6. Year 1 is the year that the Thames Tideway Tunnel project would be brought into operation. Year 6 provides sufficient time after operation commences to allow the longer term effects on aquatic ecology to be assessed. There are no site specific variations for undertaking the operational assessment of this site.

5.3.10 Section 5.6 details the likely significant effects arising from the operation of the proposed development at the Albert Embankment Foreshore site. The effects of the interception of all of the CSOs within the Thames Tideway Tunnel project on aquatic ecology receptors at a river wide level are considered in Vol 3 Section 5.

5.3.11 Only the scheme detailed in para. 5.3.7 is considered relevant to the aquatic ecology base case. Similarly, there are no other schemes listed in the site development schedule (Vol 16 Appendix N) under construction which would be in-river, adjacent to the river or discharging to the river. Thus there are no schemes that could lead to a cumulative impact at Albert Embankment Foreshore. Therefore no cumulative impact assessment has been undertaken.

5.3.12 As with construction (para. 5.3.8), the assessment of operational effects also considers the extent to which the assessment findings would be likely to be materially different should the programme for the Thames Tideway Tunnel project be delayed by approximately one year.

Assumptions and limitations

5.3.13 The assumptions and limitations associated with this assessment are presented in Vol 2 Section 5. Site specific assumptions and limitations for this assessment are detailed below.

Assumptions

5.3.14 It has been assumed that:

a. The campsheds would be concrete structures.

b. It would be necessary to remove any soft material within the temporary cofferdam and campsheds in order to establish a stable construction platform, as detailed in Section 5.2.

c. Campsheds would be constructed using the method similar to that described in 5.2.2b for the temporary cofferdams. Sheet piles would be used to create the outer edge of the campshed. Soft material would be removed from within the sheet piled area and replaced with a more coarse material similar to the existing river bed in order to provide stability. Concrete would be placed into the sheet piled area on top of a geotextile membrane.

d. The area between the outer edge of both temporary cofferdams and the maximum extent of working area would be subject to disturbance and consolidation from jack up barges and similar equipment, particularly during cofferdam installation

e. That there would be illumination at this facility and campshed given the need for winter and evening working until 10pm and occasionally 24hrs.

f. There would be no dredging required whilst the campsheds are in use.

g. The trigger level for implementing scour protection measures (para. 5.2.3) would be set to ensure that scour would not penetrate below the depth of the existing substrate (i.e. there would be no change in broad habitat type as a result of scour).

Limitations

5.3.15 There are no site specific limitations.

5.4 Baseline conditions

5.4.1 The following section sets out the baseline conditions for aquatic ecology within and around the site. Future baseline conditions (base case) are also described.

Current baseline

5.4.2 The following section sets out the existing baseline applicable to this site. The section begins with a discussion of any statutory (i.e. with a basis in law) or non-statutory (i.e. designated only through policy) sites designated for their nature conservation value. It then addresses habitats, followed by the species receptors associated with those habitats, namely marine mammals, fish, invertebrates and algae. This order is followed throughout the assessment sections.

Designations and habitats

5.4.3 This section sets out the effects on designations and habitats applicable at the site specific level. Designations and habitats applicable at the project wide scale are assessed in Vol 3 Section 5.

5.4.4 The tidal Thames is part of the proposed Thames Estuary South East Marine Conservation Zone (MCZ no. 5), the details of which were submitted to Government in early 2012. If adopted, it will be designated as a national statutory site under the Marine and Coastal Access Act 2009. The purpose of MCZs is to protect the full range of nationally important biodiversity, as well as certain rare and threatened species and habitats. Species include smelt (*Osmerus eperlanus*), European eel (*Anguilla anguilla*) and tentacled lagoon worm (*Alkmaria romijnii*) (Balanced Seas, 2011) [4]. The tidal Thames offers important spawning and migratory habitat for smelt, and migratory habitat for European eel..

5.4.5 There are no other international or national statutory sites (i.e. Sites of Special Scientific Interest or Local Nature Reserves) designated for aquatic ecology within the assessment area.

5.4.6 The Albert Embankment Foreshore site falls within the non-statutory River Thames and Tidal Tributaries SINC Grade M[iii]. The SINC, is designated by the Greater London Authority (GLA) and adopted by all boroughs which border the River Thames, recognises the range and quality of estuarine habitats including mudflat, shingle beach, reedbeds and the river channel itself. The SINC citation notes that over 120 species of fish have been recorded in the tidal Thames, though many of these are only occasional visitors. The more common species include dace (*Leuciscus leuciscus*), bream (*Abramis brama*) and roach (*Rutilus rutilus*) in the freshwater reaches (described in para. 5.4.8), and sand-smelt (*Atherina presbyter*),

[iii] SINC (Grade M) = Site of Importance for Nature Conservation (Grade III of Metropolitan importance)

flounder (*Platichtyhys flesus*) and Dover sole (*Solea solea*) in the estuarine reaches. Important migratory species include Twaite shad (*Alosa fallax*), European eel, smelt, salmon (*Salmo salar*) and sea trout (*Salmo trutta*). A number of nationally rare snails occur, including the swollen spire snail *Mercuria confusa*, as well as an important assemblage of wetland and wading birds.

5.4.7 The tidal Thames is the subject of a *Habitat Action Plan* (*HAP*) within the *London Biodiversity Action Plan* (*BAP*) (Thames Estuary Partnership Biodiversity Action Group, undated)[5]. The targets prescribed for this *HAP* are reflected in the LB of Lambeth *BAP* (LB of Lambeth, 2005)[6]. The tidal Thames *HAP* identifies a number of habitats and species which characterise the estuary, such as gravel foreshore, mudflat and saltmarsh. A number of these habitats and species, including mudflat, are also the subject of action plans under the UK *BAP*.

5.4.8 The river is divided into three zones within the tidal Thames *HAP*; freshwater, brackish and marine (Vol 3 Figure 5.4.1, see separate volume of figures). The brackish zone is equivalent to the category known as ‘transitional water’ or estuaries under the Water Framework Directive (WFD). Further details of the WFD river zone classifications can be found in Vol 3 Section 5.

5.4.9 The boundary between the freshwater and brackish zones lies within Lambeth, at Vauxhall Bridge. The Albert Embankment Foreshore site lies on the boundary of the freshwater and brackish zones, which means that the fish and invertebrate communities which occur within the river at this location consists of a mixture of more saline-tolerant freshwater species and more freshwater tolerant marine species. The distribution of salinity-sensitive species may shift seasonally and from year-to-year, depending on fluvial inputs, so that community composition can vary. Invertebrate diversity is generally higher in the freshwater zone than in the brackish zone but species must be able to withstand some variations in salinity and a stressful environment. Stress is caused by the fluctuating conditions, which means that flora and fauna have to be able to tolerate wide variations in their physical environment.

5.4.10 The intertidal habitat at Albert Embankment Foreshore was recorded as consisting of a pebble dominated foreshore, with shingle and sand. The site is not located within an area of UK *BAP* priority habitat, however the UK *BAP* priority habitat ‘mudflats’ (Natural England, 2012)[7] occurs approximately 50m downstream.

5.4.11 The river in this location is confined by a vertical river wall. There is no marginal or high tide vegetation, although the vertical river wall supports communities of macro and micro algae.

5.4.12 A summary of habitat types present, and other features of interest are presented in Vol 16 Table 5.4.1 below. The survey area is presented in Vol 16 Figure 5.4.1 (see separate volume of figures).

Vol 16 Table 5.4.1 Aquatic ecology – principal habitat, substrate and other features of interest at Albert Embankment Foreshore

UK *BAP* target habitats present and features of interest	Substrate present in intertidal zone (approximate cover in %)	Substrate present in subtidal samples
Gravel foreshore Sublittoral sand and gravels River wall	Pebbles (75%) Shingle (15%) Sand (10%)	Gravel Pebbles Sand

Evaluation of habitats for Albert Embankment Foreshore

5.4.13 The value of the habitats for individual aquatic ecology receptors is described in the relevant baseline sections. For the purpose of this assessment the habitats are considered to be of medium (metropolitan) value as part of the River Thames and Tidal Tributaries SINC (Grade M).

Marine mammals

5.4.14 Records compiled by the Zoological Society of London for 2003-2011 indicate that single records of common dolphin (*Delphinus delphis*) and harbour porpoise (*Phocoena phocoena*) have been made at Vauxhall Bridge adjacent to the site. Seals have occasionally (less than once per annum) been recorded in this stretch of the Thames and the tidal Thames upstream of the site is used by grey seal (*Halichoerus grypus*) and common seal (*Phoca vitulina*).

Evaluation of habitats for Albert Embankment Foreshore

5.4.15 The site is considered to be of low-medium (local) value for marine mammals given the small number of records seal, and the limited extent of suitable habitat.

Fish

5.4.16 In general, tidal Thames fish populations are mobile and wide ranging. Although the abundance and diversity of fish at any one site may provide some indication of the habitat quality offered at that site it is important to consider the data within the context of sites throughout the tidal Thames, since the factors influencing distribution are likely to be acting at this wider scale. To this end, the findings of the Thames Tideway Tunnel project site specific survey, relevant juvenile fish surveys and EA background data are presented in this section and are used to inform the evaluation of the site. Effects at the project wide scale are assessed in Vol 3 Section 5.

Baseline surveys

5.4.17 A single day survey was undertaken at Albert Embankment Foreshore during October 2010. Full details of the methodology and rationale for timing of surveys are presented in Vol 2 Section 5. The area covered by the survey is illustrated in Vol 16 Figure 5.4.1 (see separate volume of figures.)

5.4.18 Fish are routinely categorised into ‘guilds’ according to their tolerance to salinity and habitat preference (Elliott and Taylor, 1989[8]; Elliott and Hemingway, 2002[9]) which can be defined as follows:

a. Freshwater – species which spend their complete lifecycle primarily in freshwater.

b. Estuarine resident – species which remain in the estuary for their complete lifecycle.

c. Diadromous – species which migrate through the estuary to spawn having spent most of their life at sea.

d. Marine juvenile – species which spawn at sea but spend part of their lifecycle in the estuary.

5.4.19 The survey recorded very low fish abundance in the area of Albert Embankment, with only nineteen individuals captured in total. The range of species recorded and the number of individuals is presented in Vol 16 Table 5.4.2.

Vol 16 Table 5.4.2 Aquatic ecology - Results of fish surveys at Albert Embankment Foreshore

Common name	Specific name	Number of individuals	Guild
Common goby	*Pomatoschistus microps*	2	Estuarine resident
Smelt	*Osmerus eperlanus*	8	Diadromous
Common bream	*Abramis brama*	6	Diadromous
Dace	*Leuciscus leuciscus*	2	Freshwater
Roach	*Rutilus rutilus*	1	Freshwater

5.4.20 This was the lowest return of all sites sampled in terms of relative numbers of fish in the survey, compared with a catch exceeding 200 fish each at Barn Elms, Western Pumping Station and Cremorne Wharf Depot, which had the highest relative numbers of fish of all sites surveyed in relation to the Thames Tideway Tunnel project. The low abundance of freshwater species at Albert Embankment Foreshore such as roach, bream and dace is explained by the site location, which is at the downstream end of the freshwater zone where salinity is relatively close to the tolerance threshold of freshwater species.

Juvenile fish data

5.4.21 The shallow river margins, which shift across the intertidal foreshore with the ebb and flood of the tides, provide an important migration route for juvenile fish along the estuarine corridor. The young of species such as eel (known as glass eels or elvers), flounder, dace and smelt rely upon access to these areas of lower water velocity to avoid being washed out by tides and to avoid predation by the larger fish that occur in deeper water. Young fish also feed predominantly amongst the intertidal habitat. Adult migrants of larger fish tend to use faster mid-channel routes.

5.4.22 Surveys for juvenile fish were undertaken at Chelsea Embankment Foreshore, 2km upstream of Albert Embankment Foreshore as part of a suite of five sites sampled six times between May and September 2011 as part of the project wide assessment. The site location is presented in Vol 2 Figure 5.4.4 (see separate volume of figures). The aim of the survey was to record juvenile fish migrations through the tidal Thames inform a study of the hydraulic effects of the temporary and permanent structures on fish migration. The extent of the surveys and details of the methodology are presented in Vol 2 Section 5. The results are presented in Vol 16 Table 5.4.3.

Vol 16 Table 5.4.3 Aquatic ecology - results of 2011 juvenile fish surveys at Chelsea embankment

Common name	Scientific name	Number of individuals					
		Survey					
		1 May	2 late May	3 June	4 July	5 Aug	6 Sept
Smelt	*Osmerus eperlanus*	0	0	0	0	0	2
Dace	*Leuciscus leuciscus*	2	2	1	0	0	0
Flounder	*Platichthys flesus*	10	375	98	3	1	2
Goby	*Pomatoschistus* spp.	0	0	38	472	369	470
Perch	*Perca fluviatilis*	0	25	3	0	0	0
3-spined stickleback	*Gasterosteus aculeatus*	0	0	5	1	0	2
Eel	*Anguilla anguilla*	3	2	5	1	1	2
Roach	*Rutilus rutilus*	0	0	30	0	0	1
Sea bass	*Dicentrarchus labrax*	0	0	6	162	149	23
Common bream	*Abramis brama*	0	0	0	3	0	4
Sand smelt	*Atherina presbyter*	0	0	0	0	2	

5.4.23 Post-larval flounders dominated the catch from surveys two and three confirming a widespread upper estuary colonisation. Goby (*Pomatoschistus* sp.) numbers increased considerably from survey four onwards, peaking at 472 individuals in survey four. Sea bass (*Dicentrarchus labrax*) numbers also increased in surveys four and five. The survey area results indicate that the area is of importance for juvenile fish as a nursery area, which is an area spatially segregated from adult habitats, providing refuges and a ready food supply for juveniles. The intertidal and subtidal gravel habitat may offer a spawning substrate for smelt, although it lies downstream of the spawning zone for this species.

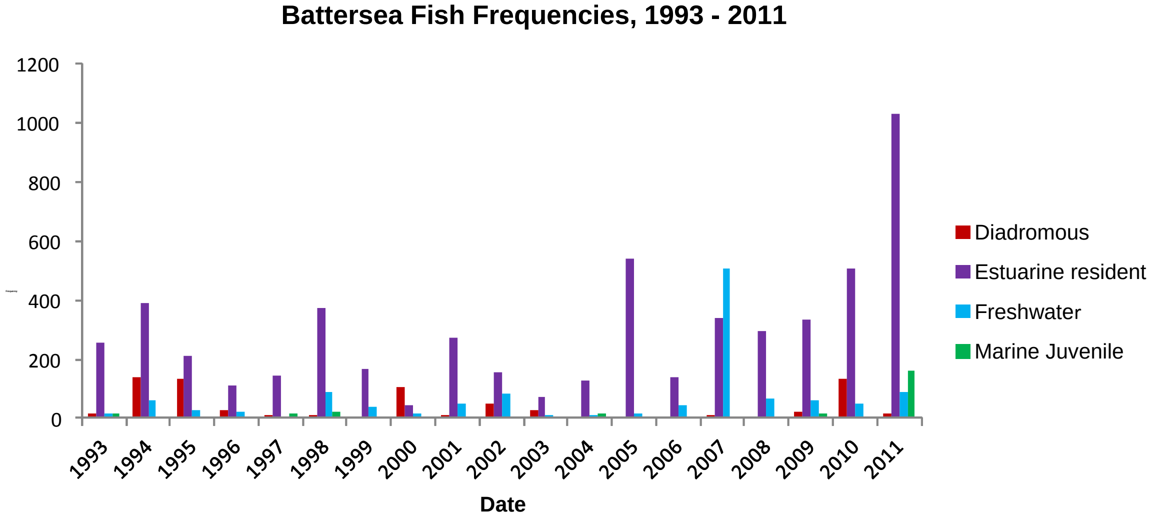
5.4.24 However, since the survey site is 2km upstream, conclusions over the value of Albert Embankment cannot be drawn from this particular survey, although it does provide a general context for this stretch of the river.

EA background data

5.4.25 EA records have also been used to provide a wider context for the fish community in the tidal Thames. The EA carry out annual surveys of fish within the tidal Thames, with data available from 1992-2011. Methodologies for the survey are provided in Vol 2 Section 5. The closest EA sampling site to Albert Embankment Foreshore is at Vauxhall within a few hundred metres, however records here are limited to 1992 and 1993 records of juvenile dace and bass. However the data collected in the October 2010 survey for this project are likely to be characteristic of this stretch of tidal Thames.

5.4.26 A more comprehensive survey dataset exists for Battersea, located approximately 3.3km upstream, where EA surveys have been carried out every year from 1993 to 2011. Fifteen fish species have been recorded at Battersea. Catches are dominated by estuarine resident fish such as common goby, flounder and sand smelt, freshwater species including dace, common bream, perch (*Perca fluviatilis*) and roach, and migratory species including eel and smelt (Vol 16 Plate 5.4.1, see separate volume of figures). Other migratory species such as salmon and sea trout must pass through the area but are present too infrequently to be detected by only one or two surveys per year. This concurs well with the more limited Vauxhall data and probably gives a better view of the overall status of fish populations in the vicinity of the Albert Embankment Foreshore site. The high frequency of freshwater species recorded in 2007 may be as a result of very high rainfall during that year. High flows may have led to a greater number of freshwater fish being washed in to the tidal Thames and lower salinity conditions which allowed them to survive.

Vol 16 Plate 5.4.1 Aquatic ecology – long-term EA total fish catches from Battersea site



Water quality and current fish baseline

5.4.27 Prior to the 1960s, water quality in the tidal Thames was heavily degraded by raw sewage inputs caused by under-capacity of sewage treatment works (STWs). With the construction of new works (Wheeler, 1979)[10] recorded the progressive improvement of fish populations from the 1960s onwards was recorded. The ecology of the tidal Thames has undergone further improvement in recent decades, with some 125 fish species now recorded by the EA.

5.4.28 However, hypoxia events (see para. 5.1.3) arising from regular CSO spills and occasional discharges of untreated waste from STWs still occur. Discharges have the effect of depleting DO (measured in mg/l) by the biological breakdown of organic matter in the discharge. This is referred to as biochemical oxygen demand (BOD). Substantial fish mortalities begin to occur when DO levels drop beneath 4mg/l. An example of the effects of a hypoxia events occurred in June 2011, in which approximately 26,000 fish were killed across the tidal Thames study area following a release of around 450,000 tonnes of untreated sewage. This incident is discussed in further detail in the project wide assessment (Vol 3 Section 5).

5.4.29 The Tideway Fish Risk Model (TFRM) was developed to evaluate DO standards for the tidal Thames (Turnpenny *et al.*, 2004)[11] as part of the *Thames Tideway Strategic Study (TTSS).* The DO standards for the tidal Thames comprise four threshold levels expressed as concentrations of DO in mg/l over specified tidal durations. Frequencies are set on the number of times per year each of these thresholds can be exceeded. Further details of the standards are presented in Vol 2 Section 14. Details of the TFRM are presented in Vol 2 Section 5 and Vol 2 Appendix C.3). The TFRM considers fish distribution and the effects of low DO conditions within defined 3km zones within the tidal Thames. The zones are based on those used by the EA's automated water quality monitoring system (AQMS), for which DO data are collected continuously. .

5.4.30 The model uses known hypoxia tolerance thresholds for seven species which are considered to represent the range of species which occur in the tidal Thames. The model is based on the assumption that for most species of fish populations will be sustainable provided hypoxia related mortality does not exceed 10% of the total population. The model considers both adult and juvenile fish (known as 'lifestage cases'), since juveniles generally have a lower tolerance to hypoxia.

5.4.31 It is not possible to isolate the contribution of individual CSO discharges on hypoxia related fish mortalities in the tidal Thames. This is because the TFRM provides outputs only at a population level. For example, DO conditions may be below a lethal threshold in one zone known to be used by a particular species of fish. However, provided conditions are above the threshold in other zones such that 90% of the population are unharmed then conditions are considered to be sustainable. The outputs are discussed in further detail in the project wide assessment (Vol 3 Section 5.6). However, TFRM results for the existing baseline suggest that a total of five of the seven species/lifestage cases are expected to suffer unsustainable hypoxia related mortality in the tidal Thames each year. Given that the indicator species used in the model act as surrogates for a wider range of ecosystem components, other sensitive taxa are also likely to be unsustainable under this water quality regime.

Evaluation of fish community for Albert Embankment Foreshore

5.4.32 The fish community at Albert Embankment Foreshore site is considered to be of medium (borough) importance due to the limited diversity and abundance of species recorded, balanced against the fact that the site is a component of the migratory route of all resident tidal Thames fish populations and in a borough context the fish populations are likely to notable.

Invertebrates

5.4.33 Benthic invertebrates are used in the freshwater, estuarine and marine environments as biological indicators of water and sediment quality since their diversity, abundance and distribution reflects natural or man-made fluctuations in environmental conditions. Species diversity is influenced by factors such as substrate and salinity. However high species diversity (or numbers of species) at any given site generally indicates good water and/or sediment quality, whilst low diversity may indicate poor quality.

5.4.34 Invertebrate populations and particularly those which occur in the water column (pelagic) are influenced by conditions throughout the estuary. The strongest influences on invertebrate distribution and density tend to be physical factors such as salinity, and substrate type followed by water quality and local habitat conditions.

Baseline surveys

5.4.35 A single day survey for invertebrates was undertaken at Albert Embankment Foreshore in autumn 2010. The area covered by the survey is the same as that described for the fish survey above (para. 5.4.18) and illustrated in Vol 16 Figure 5.4.1(see separate volume of figures.). Details of these methods can be found in Vol 2 Section 5. Two intertidal and two subtidal samples were.

5.4.36 The invertebrates collected during the October 2010 field surveys are presented in Vol 16 Table 5.4.4. The Community Conservation Index (CCI) score (Chadd and Extence, 2004)[12] has been used to identify species of nature conservation importance. CCI classifies many groups of invertebrates of inland waters according to their scarcity and conservation value in Great Britain and relates closely to the Red Data Book (RDB) (Bratton, 1991[13]; Shirt, 1987[14]) by attributing a score between 1 and 10. The higher the CCI score the more scarce the species and/or greater its conservation value.

Vol 16 Table 5.4.4 Aquatic ecology - invertebrate fauna sampled at Albert Embankment Foreshore October 2010

Taxa	**CCI Score**	**No. of individuals - subtidal samples**		**No. of individuals - Intertidal samples**		
Sample numbers		**Air Lift1**	**Air Lift 2**	**Kick sample**	**Sweep Net 1**	**Sweep Net 2**
Theodoxus fluviatilis	3	11	5	0	0	0
Potamopyrgus antipodarum	1	235	22	0	16	17
Radix balthica	1	0	32	0	0	2
Polychaeta	-	0	0	0	0	2
Oligochaeta	-	230	80	0	25	75
Helobdella stagnalis	1	0	1	0	0	0
Other long leach	-	0	1	0	0	0
Erpobdella sp.	-	0	10	0	0	1
Erpobdella testacea	5	17	0	0	0	0
Palaemon longirostris	5	0	0	0	0	1
Crangon crangon	-	0	3	0	1	0
Eriocheir sinensis	-	0	0	0	1	0
Apocorophium lacustre	8	107	80	0	0	0
Gammarus zaddachi	1	47	40	0	350	65
Number of taxa	**-**	**6**	**9**	**0**	**5**	**7**

5.4.37 Nine taxa were recorded in the subtidal samples and nine in the intertidal samples.

5.4.38 Subtidal samples are relatively diverse for this area of the tidal Thames, and moderately pollution sensitive groups, such as *Gammarus zaddachi* (a brackish species of shrimp) and *Theodoxus fluviatilis* were abundant. They were similar to most other sites on the tideway. Some moderately pollution sensitive groups such as *Corophium sp.*, *G. zaddachi* and *T. fluviatilis* were abundant in all subtidal samples.

5.4.39 The low invertebrate diversity and abundance in the intertidal area is likely to reflect the physical conditions at the site, although poor water quality due to CSO outfalls in the area may also have an influence. There is limited intertidal zone due to encroachment by the river defences and neighbouring development. Wave washing from the tide and passing river craft is therefore intense and affects the entire width of the intertidal habitat. The site also lies within the brackish zone of the river which means that invertebrates are subject to considerable variations in salinity.

5.4.40 As with other sites, the majority of the taxa present are brackish species or animals that have a varying tolerance to different levels of salinity from estuarine to near freshwater. These included *G. zaddachi* and *Crangon crangon* (shrimps, typical of estuarine and brackish conditions). However, the increasing level of salinity compared to upstream sites is demonstrated by the presence of Polychaeta, which are generally a more estuarine group.

5.4.41 The non-native species white prawn (*Palaemon longirostris*) was recorded in one of the intertidal samples, but was only recorded at one other Thames Tideway Tunnel project site: a subtidal sample at Heathwall Pumping Station.

5.4.42 As other sites, the samples on Albert Embankment were dominated by common pollution tolerant taxa, such as Oligochaeta, *Erpobdella sp.*, *Potamopyrgus antipodarum* and *Radix balthica*, as well as some more sensitive groups. The presence of the taxa Oligochaeta (worms), which thrives in organically polluted conditions, in the intertidal zone may reflect the influence of the CSO outfall in reducing background water quality,. However, this is unlikely to be as important as those factors such as salinity and substrate type.

5.4.43 The only species of high nature conservation importance was the mudshrimp *Apocorophium lacustre* (CCI 8). It is a RDB species. It was only present in low numbers at the site and limited to subtidal samples. EA data have shown *A. lacustre* to be common in the tidal Thames and therefore the relative value of the invertebrate community is not considered to be higher in this instance.

Environment Agency (EA) background data

5.4.44 Albert Embankment is located approximately 1.9km upstream of the EA site at South Bank Centre, which is the nearest sampling location with recent data (2005-2007). The most abundant taxa that have been recorded at South Bank Centre between 2005 and 2007 included *G.*

zaddachi, *Limnodrilus hoffmeisteri* and other Oligochaete worms and *P. antipodarum*.

5.4.45 In addition to the native *G. zaddachi*, the amphipod *Gammarus tigrinus*, of North American origin, was recorded at Southbank Centre in 2007. The species was not sampled at Albert Embankment Foreshore in 2010.

5.4.46 It is believed that this species of amphipod arrived in English waters via ballast water from ships. It lives in fresh and brackish waters and can expand rapidly, outcompeting local amphipods. However, based on available data, it appears to be much less abundant than the native *G. zaddachi* within the tidal Thames.

5.4.47 Species diversity recorded at Albert Embankment during October 2010 is broadly consistent with data collected by the EA at South Bank Centre, and primarily reflects the mid-estuarine conditions at the site. Fewer species of animals are able to tolerate these intermediate levels of salinity than in true freshwater or marine environments.

5.4.48 The differences between samples taken in 2010 at Albert Embankment and samples from South Bank Centre, including the lower abundance of Polychaeta worms (one of the most diverse groups at Southbank Centre) at Albert Embankment Foreshore, are likely to reflect subtle differences in habitat, seasonal and sampling variation. The higher number of species recorded in some sample years at South Bank Centre may also reflect the greater sampling intensity during the EA surveys.

5.4.49 Chinese mitten crab (*Eriocheir sinensis*), an invasive species, was sampled in the intertidal zone of the site. Individual mitten crabs were captured at a number of sampling locations along the tidal Thames, including the Albert Embankment. Mitten crabs can cause bank destabilisation and erosion, and also compete for food resources with other species. The former issue is less of a concern at this location as much of the river bank comprises hard defences, but competition with other species could occur.

Water quality and current invertebrate baseline

5.4.50 The influence of water quality, and specifically CSO discharges was investigated through statistical analysis of the EA invertebrate background data, Thames Tideway Tunnel project baseline data, and EA water quality data. The analysis is presented in Vol 3 Appendix C.1. Although it was not possible to isolate trends over time at a site specific level, a number of observations were made that helps to identify the factors influencing invertebrate abundance and diversity. For example, certain species of Oligochaete worm, present at Albert Embankment Foreshore, are indicative of polluted conditions because they are able to tolerate the low DO conditions and multiply rapidly in the enriched sediments.

5.4.51 The analysis is described in further detail in Vol 3 Section 5.4. The following summary is relevant to the brackish water zone of the tidal Thames in which the Albert Embankment Foreshore site is located.

5.4.52 The varying level of salinity and saline fluctuations appear to be a dominant factor determining the diversity and structure of benthic invertebrate assemblages. The analysis showed that, in general, samples in the brackish zone were less diverse compared with samples taken in the freshwater zone. This concurs with previous research into the invertebrate community of the tidal Thames and other estuaries, which show diversity decreasing downstream as the saline influence increases (Bailey-Brock *et al*, 2002)[15]. This is generally attributed to the fact that relatively few invertebrates are adapted to significant fluctuations in salinity. Other factors such as poor water quality and lack of habitat diversity, particularly in central London, are also likely to contribute.

5.4.53 Redundancy analysis[iv] (RDA) was used to compare the invertebrate dataset with water quality data for the period between 1992 and 2011. The analysis demonstrated the importance of environmental variables in determining the invertebrate communities in the tidal Thames. It appears that dominance of either Gammaridae (sensitive to hypoxia) or Oligochaeta (more tolerant to hypoxia) is influenced by the DO concentrations and DO sags in the tidal Thames, although other factors such as habitat are also highly important. Other invertebrate taxa also appeared to be affected by poor water quality (low DO) and/or saline intrusion, notably the insect group (mayflies), while other groups (essentially Polychaete and Oligochaete worms) were shown to be tolerant of these conditions.

Evaluation of invertebrate community for Albert Embankment Foreshore

5.4.54 The Albert Embankment Foreshore site is considered to be of medium (borough) importance due to the dominance of the invertebrate community by pollution tolerant species. Only a single species of conservation importance (*A. lacustre*) was recorded, and it is ubiquitous within the tidal Thames.

Algae

5.4.55 Algae occurs in the tidal Thames both in the water column and growing on the river wall and associated structures. The range of species which occur in the tidal Thames reflect salinity, habitat and environmental conditions. As well as their intrinsic value algal communities provide valuable habitat for invertebrates and juvenile fish. Algae are often used as an indicator of water quality, since nutrients associated with sewage promote the growth of certain species of algae. This assessment focuses on the algal communities which grow on the river wall and associated structures.

Baseline surveys

5.4.56 A single day algae survey was undertaken in May 2012 at Albert Embankment Foreshore. All records are shown in Vol 16 Table 5.4.5.

[iv] Redundancy analysis is a form of regression analysis which provides information on the influence of environmental variables on the composition/ abundances of the invertebrates assemblage.

Vol 16 Table 5.4.5 Aquatic ecology – algae sampled at Albert Embankment Foreshore October 2010

Species	Survey observations	Species presence within the Thames Estuary
Blidingia marginata	Occasional on the upper river wall, frequent in the lower quarter of the wall.	Widespread and abundant
Blidingia minima	Abundant in the top quarter of the wall; occasional in the middle half and frequent in the lower quarter of the wall..	Widespread and abundant
Cladophora glomerata	Abundant on the lower river wall.	Widespread and abundant
Rhizoclonium riparium	Abundant in the upper river wall and dominant in the lower river wall.	Common
Ulva prolifera	Occasionally present on the lower river wall.	Common
Urospora penicilliformis	Occasionally present on the lower river wall.	Occurs throughout most of the estuary
Bangia atropurpurea	Occasionally present on the lower river wall.	Occurs sporadically in brackish reaches
Vaucheria sp.	Occasionally present on the lower river wall.	The *Vaucheria sp* recorded is most probably *Vaucheria compacta*, which occurs on the upper littoral levels on sea walls. Widespread in the tidal Thames.

5.4.57 The river wall at Albert Embankment Foreshore was considered to offer optimal habitat for algae. The north facing aspect ensures that there is shading and therefore the damp conditions required to promote algal growth. The masonry construction of the wall is porous and provides a suitable substrate for algae to establish. None of the species recorded are protected under legislation and most are common in the tidal Thames. *Bangia atropurpurea* is uncommon in the tidal Thames.

Natural History Museum background data

5.4.58 Data were obtained from the Natural History Museum, London (NHM) that identifies records of marine algae received for the period from the early 1970s to 1999. Algae were recorded from a sampling location at Chelsea Bridge, located approximately 1.8km upstream of Albert Embankment Foreshore, with the records all shown in Vol 16 Table 5.4.6.

Vol 16 Table 5.4.6 Aquatic ecology – marine algae sampled at Chelsea Bridge between early 1970s and 1999

Species	Observations
Blidingia marginata	Upper littoral and supra-littoral, and floating structure just above the water-line. Widespread and abundant.
Blidingia minima	Upper littoral and supra-littoral, wood breakwaters and halophyte stems. Abundant in tidal Thames.
Ulva intestinalis	Upper littoral on sea walls. Common in tidal Thames.
Ulva prolifera	Upper mid-littoral on sea walls and on floating structures above the water line. Widespread in the estuary.
Rhizoclonium riparium	Upper mid-littoral levels on sea walls and occasionally on floating structures above the water-line. Common in the estuary.
Vaucheria compacta	Upper littoral levels on sea walls. Common in the estuary.

Water quality and algal communities

5.4.59 Algae depend on the nutrients nitrate and phosphate for growth. Although these nutrients occur naturally in water bodies, they are also present in sewage. Discharges of untreated sewage can result in elevated levels of nutrients which can lead to excessive growth of algae. As these algae die and decompose they use up oxygen in the water resulting in hypoxia (para. 5.1.3). This process is known as eutrophication. Excessive levels of algae can disrupt other elements of the ecosystem by smothering them.

5.4.60 Studies of the pelagic algae (para. 5.4.55) of the tidal Thames to inform its classification for the WFD have concluded that the estuary is not eutrophic due to strong tidal flows (English Nature, 2001)[16]. However, historically poor water quality has had a considerable negative influence on the algal communities of the tidal Thames and the loss of pollution sensitive species. Improvements in sewage treatment since the 1960s have lead to a gradual process of recovery (Tittley, 2009)[17], although pollution tolerant species such as the green algal species still dominate the community.

Evaluation of algal community for Albert Embankment Foreshore

5.4.61 None of the species recorded in Vol 16 Table 5.4.5 and Vol 16 Table 5.4.6 have protected or notable status (e.g. RDB species or UK or local *BAP* species). The algal populations are therefore given low-medium (local) value as only limited records of widespread species occur from this location.

Aquatic ecology receptor values and sensitivities

5.4.62 Using the baseline set out in paras. 5.4.1 to 5.4.61 the value accorded to each receptor considered in this assessment is set out in Vol 16 Table 5.4.7 below. The definitions of the receptor values and sensitivities used in this evaluation are set out in Vol 2 Section 5.

Vol 16 Table 5.4.7 Aquatic ecology - summary of receptors and their values/sensitivities during construction at Albert Embankment Foreshore

Receptor	Value/sensitivity
Foreshore habitat (intertidal and subtidal)	Medium-high (metropolitan)
Marine mammals	Low-medium (local)
Fish	Medium (borough)
Invertebrates	Medium (borough)
Algae	Low-medium (local)

Construction base case

5.4.63 The base case in Site Year 1 of construction would include the improvements at the five main sewage treatment works that discharge into the tidal Thames (Mogden, Beckton, Crossness, Long Reach and Riverside), and the Lee Tunnel project. TFRM modelling (Vol 3 Appendix C.3) has shown that at a river wide level there will be a reduction in the occurrence of mass or population level fish mortalities (i.e. events which result in more than 10% mortality of fish populations). However, predictions for the base case show that, even with these schemes, unsustainable mortalities of salmon, the most sensitive species can be expected. Salmon is considered as acting as a surrogate for the more sensitive aspects of ecology, and thus taxa other than salmon may also be harmed under this condition.

5.4.64 Given that CSOs within the tidal Thames would continue to spill, including the Brixton Storm Relief CSO and Clapham Storm Relief CSO, and no significant changes in habitat quality are anticipated the fish baseline for the Albert Embankment Foreshore site may therefore be expected to support a similar assemblage of species to the current baseline, with potentially a greater number of pollution sensitive species and life stages. Recovery due to water quality improvements will, however, be at an early stage.

5.4.65 The invertebrate analysis demonstrates that more pollution sensitive groups such as shrimps (Gammaridae) are subject to considerable fluctuations in abundances during low DO periods. With the improvements associated with the Lee Tunnel scheme and sewage treatment works upgrades at Mogden, these fluctuations are likely to be reduced. Whilst there may be minor changes, increases in abundance and diversity will however be limited by the fact that even with the Lee Tunnel and STW improvements in place there are still predicted to be numerous failures of DO standards. Colonisation by DO sensitive taxa such as Corophiidae, Crangonidae and Gammaridae which would otherwise occur within the fresh water or brackish water zones, including Albert Embankment Foreshore, would continue to be suppressed. As for fish, recovery of the invertebrate communities would be at an early stage. The recovery in algal communities that has taken place since the 1960s is expected to continue under the base case, however the baseline conditions are not anticipated to change from that described in Section 5.4. No changes in marine mammals are anticipated as they are relatively insensitive to point source sewage discharges.

5.4.66 There is unlikely to be encroachment onto the River Thames foreshore for non-river dependent uses as this is restricted through *London Plan 2011* (GLA, 2012)[18] Policy 7.28 Restoration of the Blue Ribbon Network which states that development should 'protect the value of the foreshore of the Thames and tidal rivers'. The EA's *National Encroachment Policy for Tidal Rivers and Estuaries* (Environment Agency, 2005)[19] also presumes against developments riverward of the existing flood defences where these would, individually or cumulatively, change flows so that fisheries were affected or cause loss or damage to habitat. Therefore no change to the current baseline from other developments is considered likely.

Operational base case

5.4.67 The river wide recovery in fish and invertebrate communities that will occur as a result of the Lee Tunnel and sewage treatment works upgrades will have advanced by Year 1 and Year 6 of operation due to the reduced number of hypoxia events. However, as noted in para. 5.4.63 there will still be unsustainable mortalities of salmon, and possibly other sensitive taxa. Further, catchment modelling shows that the frequency, duration and volume of spills from the Brixton Storm Relief CSO and Clapham Storm Relief CSO will continue to rise due to population growth, which will limit improvements for aquatic ecology receptors (spill frequency and volume as stated in para. 5.4.64.: further details of projected spills are provided in Section 14 of this volume. Therefore recovery due to water quality improvements will be suppressed at Albert Embankment Foreshore. As a result there are unlikely to be measurable changes in habitat quality at the site level and pollution sensitive fish species, such as salmon will continue to be suppressed. Indeed, conditions in the immediate vicinity of the CSOs may be less favourable for fish than the current baseline given the increase in frequency, volume and duration of CSO spills.

5.4.68 At a river wide scale invertebrate communities will be likely to include more pollution sensitive components as noted in para. 5.4.64 , which will also be reflected to some degree at a site level. However, increased CSO spill frequency, durations and volumes will suppress recovery and may also be less favourable than current baseline conditions.

5.4.69 The recovery in algal communities that has taken place since the 1960s is expected to continue under the base case however the baseline conditions are not anticipated to change from that described in Section 5.4. No changes in marine mammals are anticipated as they are relatively insensitive to point source sewage discharges.

5.4.70 As stated in para. 5.4.66 there is unlikely to be encroachment onto the River Thames foreshore for non-river dependent uses. Therefore no change to the current baseline from other developments is considered likely.

5.5 Construction effects assessment

5.5.1 This section presents the findings of the construction phase assessment. It outlines the construction impacts arising from the proposed development and the likely significant effects on aquatic ecology receptors.

Construction impacts

Temporary landtake

5.5.2 There would be a total of approximately 6965m^2 of temporary landtake, with approximately 6385m^2 from intertidal habitat and 580m^2 from subtidal habitats associated with cofferdams and campsheds. This represents 0.03% of the River Thames and Tidal Tributaries SINC (Grade M). Any soft material (i.e. silt or peat) from within the temporary cofferdam would be removed and a geotextile membrane used to separate the underlying substrate from the imported granular fill material. The structures would be in place for a total of three years, which is therefore the duration of this temporary impact.

5.5.3 Where scour protection is not required around the permanent structure (see para. 5.2.10), reinstatement would involve the removal of imported granular fill and the geotextile membrane. Where soft material had been removed in order provide stable conditions within the cofferdam (see para. 5.2.2b) this would be replaced with an appropriate substrate material. The approach to reinstatement at each of the foreshore sites is presented in Vol 3 Appendix C.4. The objective would be to restore the area to a profile similar to the surrounding foreshore.

5.5.4 Given the uncertainty over the re-establishment of the habitat, the impact of temporary landtake is considered to be medium negative. The probability of the impact occurring is considered to be certain.

Temporary landtake due to access trackway

5.5.5 The trackway would cover approximately 170m^2 of foreshore. The trackway is expected to be constructed with granular fill material for use by plant and materials deliveries access to the top of the cofferdam. Temporary landtake associated with the trackway is considered to have a low negative impact due to the small area of foreshore involved.

Sediment disturbance and consolidation

5.5.6 It has been assumed that the area between the outer edge of the cofferdams and the maximum extent of working area would be subject to disturbance and consolidation. At Albert Embankment Foreshore this represents a total area of approximately 6450m^2 of intertidal habitat and 9480m^2 of subtidal habitat outside the temporary cofferdams which would be affected by construction activities during the site establishment phase. There is also likely to be consolidation and disturbance within this area due to barge movements. At Albert Embankment Foreshore there would be approximately a peak monthly average of eight barge movements per day.

5.5.7 Impacts on the intertidal and subtidal habitats and associated flora and fauna are considered to be low negative, probable and temporary due to the small area likely to be subject to regular consolidation and disturbance within the maximum working area boundary.

Change to scour and accretion patterns

5.5.8 The approach to addressing scour associated with the temporary structures is summarised in para. 5.2.3. It consists of monitoring the structures and implementing mitigation only if trigger levels of scour are reached. Further details are provided in the Scour monitoring and mitigation strategy (Vol 3 Appendix L.4). There is currently some accumulation of sediment within the inlet that forms Lack's Dock, and in the vicinity of the river wall beneath Vauxhall Bridge. With the temporary structures the areas of accretion would increase, particularly in the embayment created between the CSO interception structure and Lack's Dock. There would also be some sediment accumulation beneath Vauxhall Bridge, and immediately upstream and downstream of the temporary works. On the upstream side of the structure there would be some occasional accumulation of sediment. These predicted areas of sediment and accumulation are illustrated in Section 14 of this volume. Based on the assumption that scour associated with the temporary structures would not be permitted to penetrate beyond the existing substrate layer (para. 5.3.14g) impacts associated with temporary scour and accretion are considered to be are considered to be low negative, probable and temporary.

Change to flow velocity

5.5.9 The presence of the temporary cofferdam would result in alterations to the hydraulic regime and this has been modelled as described in para. 5.5.6-5.5.7. The presence of temporary cofferdams at Albert Embankment Foreshore would completely obstruct channel flow along the intertidal foreshore for up to four years, and would extend up to 37m into the river at the downstream end and 60m at the upstream end. Hydraulic modelling shows that there would be an increase in maximum velocity of 9% to 1.8m/s on mean spring tides with normal fluvial flow. The impact on flow velocity is considered to be negligible.

Waterborne noise and vibration

5.5.10 There would be approximately 850m of sheet piling and bored piling installed for the temporary and permanent cofferdams. Piles would be driven using vibro- piling techniques, thus limiting the principal source of waterborne noise and vibration impacts. Further measures to limit noise and vibration impacts during the construction stage of the project have been incorporated into the *CoCP Part A* (Section 6). These are described in Section 5.2.

5.5.11 There would be additional sources of noise and vibration, including activities associated with construction of the shaft and vehicle and barge movements. Although background levels of noise and vibration within the tidal Thames are likely to be moderately high due to existing boat movements, and ground-propagated noise from transport systems, the proximity of the works to the river and their scale means that underwater noise and vibration levels are likely to be elevated locally during construction. Noise and vibration have the potential to cause physical damage to fish, and disrupt behaviour and movement. However, in this case, given the piling techniques proposed and the extent of the works relative to the width of the channel this is considered to be a low negative impact, probable and temporary.

Spillage of light from construction compound into surrounding riverine habitats

5.5.12 Light spillage into the water column has the potential to cause disturbance to fish. During construction the site would be operated 24hrs for the Clapham/Brixton connection tunnel works. As stated in the *CoCP Part A* (Section 4) (para. 5.2.5m) lighting of the construction site would be managed via a *Lighting management plan*. It has been assumed that flood lighting or similar would be designed such that it would be directed into the site or shielded to minimise illumination of the water. The extent of light spillage is therefore anticipated to be very limited, and it would be of short duration, especially during the summer months. The impact is therefore considered to be negligible, probable and temporary.

Increase in suspended sediment loads

5.5.13 Construction of the campsheds, piling operations, and barge movements are likely to lead to localised increases in suspended sediment and potentially contaminants, with the possibility for effects on local and downstream habitats.

5.5.14 Chemical analysis of sediment within the foreshore at this site has identified that levels of heavy metals, poly aromatic hydrocarbons (PAH) and other contaminants are below the Probable Effects Level (the concentration above which adverse effects are most likely to occur if sufficient exposure takes place). As such impacts related to mobilisation of contamination can be discounted.

5.5.15 It is likely that the cofferdams and campsheds would impact on scour patterns while in place, which could cause the mobilisation of increased levels of suspended solids into the river. However, the Thames is a high sediment environment and 40,000t (or 20,000m^3 assuming an in-situ density of 2t per m^3) of sediment (HR Wallingford, 2006)[20] are estimated to be carried on a spring tide. In this context, the volumes produced by the construction works from piling or scour would not be detectable against natural fluctuations in sediments and would not have an impact on surface water resources (HR Wallingford, 2012)[21]. Impacts are considered to be low negative, probable and temporary.

5.5.16 Measures and safeguards to minimise the risk of accidental releases of silty or contaminated discharges to the tidal Thames are included in the *CoCP Part A* (Section 8). These are described in Section 5.2. No impacts from polluted discharges are anticipated with these control measures and safeguards in place.

Construction effects

5.5.17 The following section (paras. 5.5.18 to 5.5.48) describes the effects of these impacts on aquatic ecology receptors based on the significance criteria set out in Vol 2 Section 2.3. Only those impacts which are considered relevant to each receptor are assessed, in accordance with the methodology presented in Vol 2 Section 5.

Designations and habitats

Loss of intertidal and subtidal habitat due to temporary landtake

5.5.18 There would be a temporary loss of approximately 6385m^2 of intertidal habitat from cofferdams and a temporary trackway at the Albert Embankment Foreshore site, and approximately 580m^2 of subtidal habitat due to presence of a campshed and realignment of the Lacks Dock slipway. There would also be localized losses due to scour. The habitats affected by temporary landtake are presented in Vol 16 Table 5.4.1 and include gravel foreshore, sublittoral sand and gravels, and a river wall. These habitats which are considered to be of medium (metropolitan) importance are represented elsewhere across the tidal Thames. The impact of temporary landtake is considered to be of medium negative magnitude.

5.5.19 Subsequent excavation and removal of the granular fill material followed by reinstatement of substrate of comparable particulate material to the original substrate would facilitate recovery. This is expected to lead to establishment in the medium (1-5 years) or long term (+5 years). Habitats within the area occupied by the campsheds would be expected to recover more rapidly since the level of disturbance would be lower. However, this does not affect the overall effect level. The overall effect is considered to be **moderate adverse**, given the medium (metropolitan) value of the receptor.

Change in intertidal and subtidal habitat due to scour and accretion

5.5.20 The intertidal habitats at Albert Embankment Foreshore are dominated by pebbles with underlying gravel and sand (Vol 16 Table 5.4.1). There may be some removal of the finer material in the areas subject to abutment and contraction scour, although based on the assumption that scour would not be permitted to develop beyond the depth of the existing broad habitat type, which is river gravel deposits. Changes are thus anticipated to be limited to minor and localised changes in the relative composition of the substrate types.

5.5.21 There would be an increase in the proportion of fine sediments in the vicinity of the site due to accretion. This may result in localised changes in the composition of the habitat as sediments accumulate on top of the coarser material. There is a risk that anoxic (i.e. low DO) conditions) can develop within accreted sediment with potentially adverse effects on sediment dwelling organisms.

5.5.22 Overall, the effect of scour and accretion is considered to be **minor adverse** given the medium (metropolitan) importance of the receptor and the low negative impact.

Disturbance and consolidation of intertidal and subtidal habitat

5.5.23 There would be disturbance and consolidation of approximately 6385m^2 of intertidal habitat and 9480m^2 of subtidal habitat outside the cofferdam during the site establishment phase due to the presence of a jack up barge to install the temporary cofferdams. The jack-up barge may also be used to remove the piles once construction is complete. Habitats within this zone are expected to recover within the short term (less than 12 months) following site establishment. Coupled with the medium (metropolitan) intrinsic value of the habitats in this area the effect is considered to be **minor adverse** due to the low negative magnitude of the impact.

Marine mammals

Interference with the migrations of marine mammals within the tidal Thames

5.5.24 Noise, vibration and other construction activity has the potential to disturb marine mammals and deter them from passing the site. However, given the low-medium (local) value of the receptor and low negative magnitude of impact, the vibro piling methods proposed, the duration of the period when piling would be taking place, and the controls on underwater noise-generating activities described in the *CoCP Part A* (Section 6), (see Section 5.2) this is considered to be a **negligible** effect.

Fish

Loss of feeding, resting and nursery habitat for fish due to temporary landtake

5.5.25 The site is not considered to offer suitable spawning habitat for smelt or any other fish species and given the limited intertidal habitat, it is unlikely to provide feeding, resting or nursery habitat. Loss of foreshore habitat is considered to be a medium negative impact. The effect on fish is considered to be **minor adverse** due to the medium (borough) value of the receptor.

Loss of feeding, resting and nursery habitat for fish due to sediment disturbance and consolidation

5.5.26 The area which would be subject to disturbance and consolidation outside the cofferdam lies primarily in the intertidal zone. Given that recovery is likely to occur within the short term (less than 12 months) the effect is considered to be **negligible**, given the medium (borough) value of the receptor and the low negative magnitude of impact.

Change in feeding, resting and nursery habitat for fish due to scour and accretion

5.5.27 The limited depths of scour predicted at this site are not predicted to result in a change in the extent or nature of feeding, resting and nursery habitats. Increase levels of accretion may cause minor localised changes in the invertebrate community. However, this is not anticipated to limit the feeding opportunities for fish. The site does not lie within the zone in which smelt and dace are known to spawn and therefore there is no risk of smothering of spawning habitats due to sediment accretion. Effects are thus considered to be **negligible** due to the medium (borough) importance of the receptor and the low negative magnitude of the impact.

Potential disturbance due to illumination of the river

5.5.28 Although fish behaviour can be altered through lighting, the illumination associated with the 24 hour construction would be primarily land-side and directed away from the river. Illumination of the river is likely to be highly localised in extent. Since it is considered an impact of negligible magnitude on a receptor of medium (borough) value it would result in a **negligible** effect.

Interference with the migratory movements of fish

5.5.29 Ideally the river channel should provide an uninterrupted route for juvenile fish migrations for species such as eel as glass eels or elvers, dace, goby (e.g. *Pomatoschistus* spp.) and flounder as they move through the estuary.

5.5.30 In general, encroachment of structures such as cofferdams into the river channel may affect the river hydraulics, particularly at high discharges associated with heavy fluvial inputs or spring tides. Changes in water velocity caused by constriction of the hydraulic channel may hinder movements of fish against the tide, including their ability to withstand, or hold station in the flow. Constriction of the hydraulic channel, reduction of the intertidal zone and increased water velocities might cause some fish to be lost, for example by forcing them into deeper water with increased predation risk. Formation of eddy currents in the wake of structures may temporarily entrap fish and delay progress of migrations. Persistently delaying the successful daily migrations of fish past individual sites may also interfere with key life stage events such as spawning through preventing fish from reaching spawning sites at appropriate times.

5.5.31 The Individual Based Modelling (IBM) used to simulate the effects of the temporary and permanent structures on juvenile fish migration demonstrates that the temporary works should benefit upstream migration by presenting more opportunities for fish to shelter from adverse currents. Although the structure would cause juvenile fish to move into deeper water where predation risk is higher, the period of time in which they are exposed to this risk is sufficiently short that the study found it would have no effect on overall mortality rates when compared to the base case. Detail of the study, including the modelling methods, are presented in Vol 3 Section 5.

5.5.32 Given the temporary nature of the works, and the fact that the minor adverse effects of fish being forced into deeper water would be offset by the minor beneficial effect anticipated through increased opportunities for shelter, the effects of the temporary structures on juvenile fish migrations are considered to be **negligible**.

Effects of waterborne noise and vibration on fish

5.5.33 The effects of waterborne noise and vibration on fish vary according to the proximity of the receptor to the source. Effects depend on distance from source, ranging from potential death at very close proximities, through injury, and behavioural disturbance with increasing distance from the source. The key sources at Albert Embankment Foreshore are the driving of sheet piles for the cofferdams. The driving of sheet piles for the cofferdams would be undertaken using techniques that minimise the level of noise and vibration. However, the period of piling would be sufficiently brief (assumed for the purposes of this assessment to be 10 weeks for sheet piling for the temporary cofferdam). Removal of the piles would take a similar length of time at the end of the construction period. Furthermore, a series of control measures relating to the timing and duration of piling operations have been included in the *CoCP Part A* (Section 6) (see Section 5.2).

5.5.34 The site is not considered to support sensitive spawning habitat, but, during surveys undertaken during 2011, was found to have value for juvenile fish as part of a migratory pathway through the tidal Thames. Waterborne noise and vibration is considered to be a low negative impact, and given that the value of the receptor is medium (borough), the overall effect is assessed as being **negligible**.

Reduction in water column visibility due to suspended sediment

5.5.35 Although the tidal Thames is a sedimentary environment with high levels of suspended solids, construction activities such as dredging, piling and barge movements may generate high levels of suspended sediment which may cause disorientation of fish.

5.5.36 Given the length and extent of cofferdams actually in contact with the tidal flow (approximately 300m of temporary cofferdam), there is the potential for re-suspended sediments from piling and barge movements to affect juvenile fish migrations, particularly when considered along with the hydraulic effects described in paras. 5.5.29 to 5.5.32. Adult fish are considered to be less likely to be affected as they are able to move away into deeper water, whilst juvenile fish are at greater risk of predation in deeper water. The effect is considered to be **negligible** due to the medium (borough) value of the receptor and low negative magnitude of the impact.

Invertebrates

Direct mortality of invertebrates due to temporary landtake, sediment disturbance and consolidation

5.5.37 There would be direct mortality of invertebrates within sediments removed or covered by the cofferdams and temporary trackway and due to consolidation and disturbance of sediment due the site establishment phase and realignment of the Lacks Dock slipway. The effect is considered to be **negligible** due to the low negative magnitude of impact and medium (borough) value of the receptor.

Loss of burrowing and feeding habitat for invertebrates due to temporary landtake

5.5.38 The area beneath the temporary cofferdams and temporary trackway would also be lost as burrowing and feeding habitat for invertebrates during the entire construction period (three and a half years). Subsequent excavation and removal of the granular fill material followed by reinstatement of substrate of comparable particulate material to the original substrate would facilitate recovery.

5.5.39 The overall effect is considered to be **minor adverse**, given the medium (borough) value of the receptor, medium negative magnitude of impact, relatively limited loss of a burrowing and feeding resource, and the presence of possible new habitat provided by the temporary structures.

Loss of feeding and burrowing habitat for invertebrates due to sediment disturbance and consolidation

5.5.40 The area beneath the temporary cofferdam would be subject to heavy consolidation, and hence would be unavailable to burrowing invertebrates in the medium term (one to five years) following removal of the cofferdam. The temporary consolidation and disturbance to the habitat for burrowing invertebrates is considered to be a **negligible** effect. This is because the receptor is of medium (borough) value, the impact of sediment disturbance and consolidation is considered to be low negative, and the effects are considered likely to be reversed upon recovery of the habitat, which would occur in the short term (less than 12 months).

Change to burrowing and feeding habitat due to scour and accretion

5.5.41 Whilst there may be some losses of fine material in the localised areas where scour is predicted, this is not anticipated to result in a change in the invertebrate community. The increase in the proportion of fine material associated with accretion may favour certain benthic invertebrates including the sediment dwelling Oligochaeta and Polychaeta. Oligochaeta are already the dominant benthic invertebrate group at the site and the change in the proportion of fine sediments is unlikely to change the overall community composition.

5.5.42 Overall, the effects are considered to be negligible due to the low negative magnitude of the impact and the medium (borough) importance of the receptor.

Reduction in water quality due to suspended sediment

5.5.43 The predicted increases in suspended sediment due to general construction activity such as barging are not expected to affect invertebrate communities given the existing background levels within the tidal Thames. However, high levels of suspended sediment which may occur as a result of a sudden scour events could give rise to localised reductions in DO and potentially, increases in the concentrations of contaminants.

5.5.44 The majority of the invertebrates present are not considered to be particularly sensitive to accretion or low DO conditions. These organisms are adapted to withstand tidal flows that bring about movements of degradable and non degradable solids. The feeding mechanisms of animals that filter water might be affected (e.g. larger bivalves), but these are sparsely recorded in the tidal Thames. Tube living animals such as

Corophiidae might be more susceptible, but they are quite mobile and able to move away from sources of impact.

5.5.45 Effects are thus considered to be **negligible**, given the medium (borough) value of the receptor and the low negative magnitude of the impact.

Algae

Loss of habitat due to temporary landtake

5.5.46 The construction of temporary cofferdams would mean that any algae would be lost from the area of wall within the structures, as the algae require regular inundation with water in order to survive. However, given the low-medium (local) value of the receptor and the fact that algae are likely to re-colonise rapidly following removal of the cofferdams, the effect is considered **negligible**.

Blanketing of areas and increase in water column turbidity due to suspended sediment

5.5.47 As stated in para. 5.5.15, the tidal Thames is already a sedimentary environment with high levels of suspended solids. The generation of increased levels of suspended sediment from construction activities may cause smothering of marine algae.

5.5.48 Given the length and extent of cofferdams in contact with the tidal flow as described in (para. 5.5.36), there is the possibility that re-suspended sediments may affect marine algae located on river walls immediately downstream. The value of the receptor is low-medium (local) and the impact considered low negative and therefore the effect is considered to be **negligible**.

Sensitivity test for programme delay

5.5.49 For the assessment of effects on aquatic ecology during construction, a delay to the Thames Tideway Tunnel project of approximately one year would not be likely to materially change the assessment findings reported above (paras. 5.5.17 - 5.5.48). This is because there are no developments in the site development schedule (Vol 16 Appendix N) that would fall into the base case as a result of this delay and therefore the base case would remain as described in paras.5.4.63 - 5.4.66.

5.6 Operational effects assessment

5.6.1 This section presents the findings of the operational phase assessment. It outlines the operational impacts arising from the proposed development and the likely significant effects on aquatic ecology receptors.

Operational impacts

Permanent landtake due the presence of permanent structures on the foreshore

5.6.2 There would be approximately 4020m^2 of landtake (of which 1105m^2 of intertidal habitat and 410m^2 of subtidal habitat would be associated with a permanent apron that would consist of buried rip rap, which would be overlaid with an appropriate substrate material. The remaining 2505m^2 of intertidal habitat would be associated with the cofferdam for the permanent foreshore structures and permanent advancement of the river wall. The permanent CSO structures would extend into the channel in two locations, extending approximately 16m into the channel west of Vauxhall Bridge, and approximately 26m immediately east of the bridge. This would result in loss of intertidal feeding and resting habitat for fish and invertebrates. Permanent landtake is certain and is considered to have a medium negative impact.

Modification of habitat as a result of scour protection measures

5.6.3 As noted above, the outfall at Albert Embankment Foreshore would include a CSO outfall apron to prevent residual discharges scouring the surrounding bed. Scour protection would also be provided around the perimeter of the permanent foreshore structure. Scour protection (including aprons) would comprise buried rip rap. A total area of up to 1105m^2 of intertidal habitat and 410m^2 of subtidal habitat is likely to be affected by scour protection at the Albert Embankment Foreshore site.

5.6.4 This is regarded as a low negative impact as habitat modification, rather than habitat loss, would result.

Change to scour and accretion patterns

5.6.5 The permanent foreshore structures would extend approximately 26m into the channel. Hydraulic modelling has shown that the cofferdam would impact on scour patterns.

5.6.6 Scour protection would be provided beneath the new outfall where it extends below the mean low water line, in the form of an outfall apron, and along the line of the new river wall (to protect its foundation). The detailed design and extent of this shall seek to avoid or minimise adverse effects on aquatic ecology as stated in the design measures (para. 5.2.11b).

5.6.7 With the permanent structure in place, some sediment accumulation is predicted to occur immediately downstream and to a greater distance upstream of the permanent foreshore structures within the intertidal zone, with some occasional deposition predicted both immediately downstream and over a greater distance upstream of the permanent foreshore structure within the intertidal zone. These predicted areas of sediment and accumulation are illustrated in Section 14 of this volume.

5.6.8 Impacts on the intertidal and subtidal habitats and associated flora and fauna are considered to be low negative, probable and permanent, due to the reduced area likely to be subject to scour following incorporation of scour protection.

Change to flow velocity

5.6.9 The presence of the permanent foreshore structure would result in alterations to the hydraulic regime. On a mean spring tide, maximum velocities are predicted to increase by 3% to 1.7m/s on normal fluvial flows. There would be a zone of reduced velocities adjacent to the works and in their wake along the left foreshore. The impact is considered to be negligible.

Increases in dissolved oxygen concentrations in the vicinity of the CSO

5.6.10 The projected Typical Year 95% decrease in the volume of discharges compared against the base case (see para. 5.2.8) would result in improvements in DO concentrations at a local level, and throughout the tidal Thames, and would contribute to a river wide improvement arising from the project. The Thames Tideway Tunnel project improvements would ensure compliance with the DO standards described in para. 5.4.29. These improvements are assessed at a river wide level in Vol 3 Section 5. The impact is considered to be medium positive due to the existing relatively large number and volume of spills from the Brixton Storm Relief CSO and the Clapham Storm Relief CSO, and impacts would be near certain and permanent.

Reduction in sediment nutrient levels

5.6.11 Elevated concentrations of nutrients (phosphate and nitrate) are likely to have accumulated in the sediments in proximity to the existing CSO discharge points as a result of the faecal material and sewage derived litter discharged from the CSOs. In addition to the directly toxic effects of elevated ammonia (particularly in low oxygen situations) increased nutrients in the sediment can reduce the natural limits on algal growth and enable more nitrogen/phosphate responsive species to outcompete other species reducing diversity. Interception of the CSOs would lead to a gradual reduction in sediment nutrient levels. The impact is considered to be low positive, probable and permanent.

Reduced levels of sewage derived litter

5.6.12 Sewage derived litter from the CSOs can be expected to reduce by approximately 95%, from approximately 74t to 3.5t, in the Typical Year with beneficial effects on aquatic ecology receptors.

5.6.13 This is considered to be a low positive impact and would be near certain and permanent.

Creation of new intertidal terraces

5.6.14 As stated in paras. 5.6.19 and 5.6.31 the permanent structure has been designed to include vegetated intertidal terraces cut back into the overall footprint of the structure, and connecting the interception chamber with the drop shaft. The vegetation would comprise reed vegetation (common reed and sea club-rush) which are characteristic of the marginal habitats that may be expected to occur naturally in the brackish zone of the river. This is considered to be a medium positive impact, and would be certain and permanent.

Operational effects

5.6.15 The following section describes the effects of these impacts on aquatic ecology receptors based on the significance criteria set out in Vol 2 Section 2.3. Only those impacts which are considered relevant to each receptor are assessed, in accordance with the methodology presented in Vol 2 Section 5. Unless stated the effects described below apply to both Year 1 of operation and Year 6 of operation.

Designations and habitats

Permanent loss of intertidal habitats

5.6.16 There would be a permanent loss of approximately 2505m^2 of intertidal habitat due to the permanent structure. A further 1105m^2 of intertidal habitat and 410m^2 of subtidal habitat would be modified as a result of the scour protection measures and permanent apron. This would consist of buried rip-rap which would be overlaid with an appropriate substrate material. The effect is considered to be **moderate adverse** due to the magnitude of the impact (medium negative) and the medium (metropolitan) value of the receptor.

Change in intertidal and subtidal habitat due to accretion

5.6.17 The modelling results have predicted some changes in sediment accumulation and occasional deposition as a result of the permanent foreshore structure. Therefore overall the effect of accretion is considered to be minor adverse, given the medium (metropolitan) value of the receptor and low negative impact.

Improvements in habitat quality through changes in water quality

5.6.18 The predicted increases in DO concentrations and reductions in BOD, ammonia and nutrients within the sediment would result in localised improvements in habitat quality. This may be characterised by increased levels of photosynthesis by microscopic algae within the sediments, termed primary production. These algae form the basis of the estuarine food chain, providing a food source for fish and invertebrates. The gradual breakdown and removal of sewage derived litter associated with the sewage discharge would contribute to the recovery. However, habitats per se are relatively insensitive to alterations in DO concentrations, with reductions in sediment nutrient levels and sewage derived litter more important factors with regards to habitat quality improvements. Therefore the impact in this instance is considered to be of low positive magnitude, rather than medium positive. The effects are considered to **negligible** at Year 1 increasing to **minor beneficial** by Year 6, given the medium (metropolitan) value of the receptor and the low positive impact magnitude.

Increase in the area of intertidal habitat

5.6.19 The new intertidal terraces would provide new vegetated habitat within a stretch of the river characterised by vertical river walls and a limited intertidal zone. The intertidal terraces are considered to improve habitat structure and diversity within the local area, as well as offering refuges for fish and burrowing substrate for invertebrates. Effects are considered to be **negligible** at Year 1 and **moderate beneficial** at Year 6 since the habitats would take time to establish, given the medium value of the receptor and medium positive impact magnitude.

Marine mammals

Increase in the number and/or change in the distribution of marine mammals

5.6.20 No changes are anticipated on marine mammals as a result of the water quality improvements associated with interception of a single CSO discharge. This is because they are relatively insensitive to point source sewage discharges. Improvements in habitat quality due to the reduction in sewage derived litter may make the habitat more favourable, although the factor determining its use by seals relates predominantly to the lack of disturbance rather than water quality. Effects are considered to be **negligible**, given the low-medium (local) value of the receptor and the low positive impact magnitude.

Fish

Permanent loss of intertidal feeding and resting habitat for fish due to landtake

5.6.21 The site is not considered to offer suitable spawning habitat for fish species, but during surveys undertaken in 2011, it was found to provide nursery habitat for juvenile fish. However, loss of 2,505m^2 of intertidal foreshore habitat is considered to be a medium negative impact on a low-medium value receptor. This is therefore considered to be a **minor adverse** effect.

Modification of intertidal feeding and subtidal habitat for fish

5.6.22 In addition to landtake, the permanent foreshore structures would have scour protection in the form of a discharge apron that would consist of buried rip-rap which would be overlaid with an appropriate substrate material. At Albert Embankment Foreshore, scour protection would occupy an area of approximately 1515m^2 (1105m^2 of intertidal and 410m^2 of subtidal habitat). The rip rap scour protection areas may offer some benefits to juvenile fish by providing refuges from the current and from predators. In this respect it is analogous to artificial reef structures created in the marine environment to provide shelter for fish and increase the heterogeneity of otherwise uniform habitats (Grove *et al.*, 1991)[22].

5.6.23 Similarly, the rip rap scour protection may offer shelter for pelagic invertebrates such as *Gammarus* which represent a food source for some fish species. It is unlikely to have potential as feeding habitat for benthic feeding fish except where accretion allows colonisation by invertebrates.

5.6.24 The effects on fish are considered to be negligible. This is because although the overall impact is low negative, the balance of positive and negative effects for fish gives rise to a **negligible** effect.

Change in feeding, resting and nursery habitat for fish due to accretion

5.6.25 The modelling results have predicted some changes in sediment accumulation and occasional deposition as a result of the permanent foreshore structure. Increase levels of accretion may cause minor localised changes in the invertebrate community. However, this is not anticipated to limit the feeding opportunities for fish. The site lies downstream of the zone in which smelt and dace are known to spawn, and furthermore the accretion changes are predicted within the intertidal zone, whilst it is the subtidal zone that provides the key spawning habitat, and therefore there is no risk of smothering of spawning habitats due to sediment accretion. Therefore overall the effect of accretion is considered to be **negligible**, given the medium (borough) value of the receptor and low negative impact.

Interference with migratory movements of fish

5.6.26 The Individual Based Modelling study shows that none of the three species (bass, eel and flounder) used to represent the range of species found in the tidal Thames flounder were affected when comparing the base case and the proposed development. This is likely to be influenced by the structures offering refuges for juvenile fish against adverse currents, and thus offsetting the slightly increased velocities resulting from the presence of permanent structures. The effect is therefore considered to be **negligible**, given the medium (borough) value of the receptor and the negligible impact magnitude.

Reduction in the occurrence of dissolved oxygen related fish mortalities

5.6.27 Interception of the CSOs throughout the tidal Thames would result in far fewer hypoxia events. The TFRM has been used to predict the change in the number of hypoxia events, and the results are reported in Vol 3 Section 5. In summary, all tidal Thames fish populations would become sustainable (ie, less than 10% mortality as a result of hypoxia (Turnpenny *et al*, 2004)[23]), compared with the current baseline in which there is a greater than 10% mortality due to hypoxia for four key species (smelt, dace, flounder and common goby).

5.6.28 Interception of the Brixton Storm Relief and Clapham Storm Relief CSOs would contribute to tidal Thames-wide improvement, but would also result in improvements in the local area. Given the range of diversity of freshwater species in particular in the upper tidal Thames the effect is considered to be **minor beneficial**, given the medium (borough) value of the receptor and the medium positive impact magnitude. Improvements across the tidal Thames as a whole are assessed in Vol 3 Section 5.

Increase in the distribution of pollution sensitive fish species

5.6.29 The tidal Thames currently supports a small number of rare fish species such as salmon, sea trout, twaite shad and river lamprey. A number of factors limit the colonisation of habitats by these species, including salinity, substrate type and current, but pollution is known to be an important factor in determining colonisation (Maitland and Hatton-Ellis, 2003)[24]. Improving water and sediment quality would facilitate the spread of those pollution sensitive species which are currently being impeded by poor water and sediment quality.

5.6.30 EA data and bespoke project surveys have indicated no records of rare fish species in the vicinity of Albert Embankment Foreshore and habitat quality at this site is limited by confinement of the river channel between vertical river walls, which limits the extent of intertidal habitat. Given that the impact is considered to be medium positive, and the value of the receptors is medium (borough), the effect is thus considered to be **negligible** in the short term (Year 1), and **minor beneficial** in the medium term (Year 6), since it would take time for fish to colonise.

Creation of new intertidal habitat

5.6.31 The intertidal terraces would offer a variety of new habitats for fish. The boulders at the base of the terraces within the subtidal zone would offer refuges from tidal currents for juvenile fish whilst the vegetated terraces would offer feeding and nursery habitat.

5.6.32 Effects are considered to be **minor beneficial** due to the medium positive magnitude of the impact and the medium (borough) importance of the receptor.

Improvement in the quality of foraging habitat

5.6.33 Intertidal habitat in the upper and middle tidal Thames is used by juvenile fish for foraging. For example, juvenile flounder, bass and smelt migrate to the tidal limit in spring and early summer and then migrate downstream in search of suitable foraging habitat. As habitat quality improves as described in para. 5.6.18 and the invertebrate community becomes more diverse (paras. 5.6.39 to 5.6.42) foraging opportunities for fish may increase. Given that the impact is considered to be medium positive, and the value of the receptors is medium (borough), the effect is considered to be **negligible** in the short term (Year 1), increasing to **minor beneficial** in Year 6 of operation as it would take time for communities to develop

Invertebrates

Permanent loss of intertidal feeding and burrowing habitat for invertebrates due to landtake

5.6.34 The area beneath the permanent works would be lost as burrowing and feeding habitat for invertebrates. Given that the impact is considered to be medium negative, and the value of the receptors is medium (borough), the overall effect is considered to be **minor adverse**.

Modification of intertidal and subtidal habitats for invertebrates by scour protection

5.6.35 As for fish the degree to which the scour protection would change conditions for invertebrates depends on the nature of the existing substrate. Fine substrates are unlikely to accumulate extensively within the rip rap scour protection given that high flow velocities which are likely to occur in the vicinity of them. Benthic invertebrates may thus be excluded from these areas, except in sheltered pockets where accretion can occur.

5.6.36 Pelagic invertebrates such as *G. zaddachi* may be attracted to these areas in order to shelter from the current.

5.6.37 The overall effect on invertebrates is considered to be **negligible**, given the medium (borough) receptor value and the low negative impact magnitude.

Change to burrowing and feeding habitat due to accretion

5.6.38 The modelling results have predicted no changes in sediment accumulation as a result of the permanent foreshore structure. The increase in the proportion of fine material associated with accretion may favour certain benthic invertebrates including the sediment dwelling Oligochaeta and Polychaeta. Oligochaeta are already the dominant benthic invertebrate group at the site and the change in the proportion of fine sediments is unlikely to change the overall community composition. Therefore overall the effect of accretion is considered to be **negligible**, given the medium (borough) value of the receptor and low negative impact.

Localised improvements in invertebrate diversity and abundance

5.6.39 Improvements in DO concentrations are likely to lead to an increase in the distribution of a range of species that are currently being suppressed by poor water quality conditions. Some of these improvements will occur under the base case due to the Lee Tunnel and STW upgrades. However, even with these improvements in place there are still predicted to be a number of occasions during an average year when DO standards would be breached. Colonisation by DO sensitive taxa such as Corophiidae, Crangonidae and Gammaridae which would otherwise occur within the freshwater zone would continue to be suppressed.

5.6.40 Full compliance with the standards as a result of the Thames Tideway Tunnel project is expected to enable colonisation by these DO sensitive taxa. In the localised areas around CSO discharges gradual reductions in organic material associated with sewage would also allow for a transition from invertebrate communities dominated by small numbers of species to a more diverse and balanced community. For example, pollution sensitive estuarine taxa such as Corophiidae, Crangonidae, Gammaridae, Sphaeromatidae, Nuculidae, Anthuridae, and Palaemonidae may be expected to increase in abundance.

5.6.41 Improvements in water quality could theoretically selectively enhance colonisation by invasive, non-native species. However, studies on mitten crabs, for example, have determined that the species is able to tolerate poor water quality, but that improvement of water quality does not necessarily lead to an increased distribution (Veilleux and de Lafontaine, 2007)[25].

5.6.42 Given that the impact is considered to be medium positive, and the value of the receptors is medium (borough), the effect is considered to be at **negligible** at Year 1 and **minor beneficial** Year 6 of operation since it would take time for new species to colonise.

Increase in the distribution of pollution sensitive invertebrate species

5.6.43 The tidal Thames currently supports a small number of rare invertebrate species, such as swollen spire snail and tentacled lagoon worm. A number of factors limit the colonisation of habitats by these species, including salinity, substrate type and current, but pollution is known to be an important factor in determining colonisation. Improving water and sediment quality would facilitate the spread of those pollution sensitive species which are currently being impeded by poor water and sediment quality.

5.6.44 EA data and bespoke project surveys have indicated no records of rare invertebrate species in the vicinity of Albert Embankment Foreshore (other than *A. lacustre* which as discussed although uncommon nationally is common in the tidal Thames). Given that the impact is considered to be medium positive, and the value of the receptors is medium (borough), the effect is thus considered to be **negligible** in Year 1, and **minor beneficial** in Year 6 as it would take time for species to colonise.

Creation of new intertidal habitat

5.6.45 The substrate within the terraces would offer additional burrowing and feeding habitat for benthic invertebrates, whilst the vegetation would offer refuges for pelagic species such as the amphipod *A. lacustre*.

5.6.46 Effects are considered to be **minor beneficial** due to the medium positive magnitude of the impact and the medium (borough) importance of the receptor.

Algae

Permanent loss of original river wall

5.6.47 The algae that have previously been found on the river wall at the Albert Embankment Foreshore site can be expected to recolonise the new river wall (i.e. the outer wall of the permanent structure) relatively quickly following the completion of construction (within 5 years). As none of these species are uncommon the effect is considered to be **negligible**, given the low-medium (local) value of the receptor.

Changes in algal communities

5.6.48 The reduction in nutrient levels, both in the water column and the sediments in the vicinity of the discharge may cause local changes to the algal communities of the river wall. Whilst it is not possible to predict these changes precisely it is likely that the reduction in nutrients would contribute to the recovery of algal flora, with pollution sensitive species becoming a more common component of the community at the expense of more pollution tolerant species.

5.6.49 However, habitat availability would remain a key factor determining the diversity and abundance of algal communities and so the effects associated with the Thames Tideway Tunnel project are considered to be **negligible**, due to the low-medium (local) value of the receptor and low positive magnitude of impact.

Creation of additional habitat for algae

5.6.50 The newly created intertidal terraces would have timber faces which offer a porous surface for colonisation by algae. Effects are considered to be **minor beneficial** given the medium positive magnitude of the impact and the low-medium (local) value of the receptor.

Sensitivity test for programme delay

5.6.51 For the assessment of effects on aquatic ecology during operation, a delay to the Thames Tideway Tunnel project of approximately one year would not be likely to materially change the assessment findings reported above (paras. 5.6.15 - 5.6.50). This is because the base case against which the operational assessment is made is likely to remain the same as described in paras. 5.4.67 - 5.4.70.

5.7 Cumulative effects assessment

5.7.1 As described in Section 5.3, during the construction phase there are no schemes within the site development schedule (Vol 16 Appendix N) that would have an impact on aquatic ecology receptors, and so no cumulative impacts with the proposed development would arise.

5.7.2 During the operational phase there are no schemes that could lead to a cumulative impact at the Albert Embankment Foreshore site.

5.7.3 Therefore the effects on aquatic ecology would remain as described in Section 5.5 and 5.6 above.

Sensitivity test for programme delay

5.7.4 In the event that the programme for the Thames Tideway Tunnel project is delayed by approximately a year, the cumulative effects assessment would remain unchanged. As described above, there are no schemes anticipated to generate cumulative effects on aquatic ecology during construction or operation and this would remain the case with a programme delay of approximately one year.

5.8 Mitigation and compensation

Mitigation

5.8.1 The approach to mitigation has been informed by the 'Mitigation and Compensation Hierarchy' consulted on with the Thames Tideway Tunnel project EA Biodiversity Working Group as a systematic and transparent decision-making process. The hierarchy is appended to Vol 2 Section 5.

5.8.2 The hierarchy is sequential and seeks to avoid adverse environmental effects. The hierarchy of 'avoid effect', 'minimise', 'control' 'compensate', and 'enhance'. The *Environmental Statement* describes how this hierarchy has been applied.

5.8.3 All *CoCP* and embedded design measures of relevance to aquatic ecology are summarised in Section 5.2. The permanent loss of intertidal foreshore is considered to be a moderate adverse effect. The footprint of the permanent structure has been minimised as far as possible to accommodate the necessary works therefore further mitigation is not possible.

5.8.4 During operation, the permanent loss of habitat at the Albert Embankment Foreshore site contributes to an overall loss arising from the ten foreshore sites that are part of the proposed development. Compensation for the cumulative, permanent loss of foreshore habitat is described in the project wide assessment (Vol 3 Section 5).

5.8.5 A monitoring programme to measure the recovery of aquatic ecology receptors throughout the tidal Thames following interception of the CSO network would be implemented.

Compensation

5.8.6 Significant adverse effects would occur due to the permanent loss of intertidal and subtidal habitats, and intertidal feeding and resting habitat for fish. On-site habitat compensation is not considered possible due to the limited availability of land to create new habitat within the boundary of the site. A package of off site measures which would compensate for significant adverse effects on habitats and fish has been developed and is reported in full in Vol 3 Section 5.8. It includes measures such as the creation of an intertidal terrace on the Bell Lane Creek, and the installation of fish passes on several structures which are currently inhibiting the migration of fish from the tidal Thames into freshwater tributaries.

5.9 Residual effects assessment

Construction effects

5.9.1 As no mitigation measures are proposed, the residual construction effects remain as described in Section 5.5. All residual effects are presented in Section 5.10.

Operational effects

5.9.2 As no mitigation measures are proposed, the residual operational effects remain as described in Section 5.6. All residual effects are presented in Section 5.10.

5.9.3 Compensation for the overall habitat loss across the Thames Tideway Tunnel project is outlined in the project wide assessment (Vol 3 Section 5). At a project wide level the total habitat losses have been addressed through sites along the route of the Thames Tideway Tunnel project to compensate for adverse effects on aquatic ecology. The loss of habitat at Albert Embankment Foreshore has been reported here without taking account of these compensation sites. This is to ensure that the local effects are presented. However, it is recognised that aquatic ecological resources are highly mobile and river wide. Reference should therefore be made to the project wide assessment which includes the compensation sites to understand the total effects anticipated to result from the Thames Tideway Tunnel project.

5.10 Assessment summary

Vol 16 Table 5.10.1 Aquatic ecology – summary of construction assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Designations and habitats	Loss of intertidal habitat due to temporary landtake	Moderate adverse	None since effect is temporary and would recover with time	Moderate adverse
	Disturbance and consolidation of intertidal and subtidal habitat	Minor adverse	None	Minor adverse
	Change in intertidal and subtidal habitat due to scour and accretion	Minor adverse	None	Minor adverse
Marine mammals	Interference with the migrations of marine mammals within the Tideway	Negligible	None	Negligible
Fish	Loss of feeding, resting and nursery habitat for fish due to temporary landtake	Minor adverse	None	Minor adverse
	Loss of feeding, resting and nursery habitat for fish due to sediment consolidation and disturbance	Negligible	None	Negligible
	Change in feeding, resting and nursery habitat for fish due to scour and accretion	Negligible	None	Negligible
	Potential disturbance due to illumination of the river	Negligible	None	Negligible
	Interference with migratory movements of fish	Negligible	None	Negligible
	Effects of waterborne noise and vibration on fish	Negligible	None	Negligible
	Reduction in water column visibility due to suspended sediment.	Negligible	None	Negligible

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Invertebrates	Direct mortality of invertebrates due to temporary landtake, sediment disturbance and consolidation	Negligible	None	Negligible
	Loss of feeding/burrowing habitat for invertebrates due to landtake	Minor adverse	None	Minor adverse
	Loss of feeding/burrowing habitat for invertebrates due to sediment consolidation and disturbance.	Negligible	None	Negligible
	Change to burrowing and feeding habitat due to scour and accretion	Negligible	None	Negligible
	Reduction in water quality due to suspended sediment.	Negligible	None	Negligible
Algae	Loss of habitat due to temporary landtake	Negligible	None	Negligible
	Blanketing of areas and increase in water column turbidity due to suspended sediment	Negligible	None	Negligible

Vol 16 Table 5.10.2 Aquatic ecology – summary of operational assessment

Receptor	Effect	Significance of effect		Mitigation	Significance of residual effect	Compensation
		Year 1	Year 6			
Designations and habitats	Permanent loss of designated intertidal habitat	Moderate adverse	Moderate adverse	None	Moderate adverse (at the site level)	Compensation would be provided through a suite of off-site habitat creation schemes which are described in Vol 3 Section 5.
	Change in intertidal and subtidal habitat due to accretion	Minor adverse	Minor adverse	None	Minor adverse	None
	Increase in the area of intertidal habitats	Negligible	Moderate beneficial	None	Moderate beneficial	None
	Improvements in habitat quality through changes in water quality	Negligible	Minor beneficial	None	Minor beneficial	None
Marine mammals	Increase in the number and/or change in the distribution of marine mammals.	Negligible	Negligible	None	Negligible	None
Fish	Permanent loss of intertidal feeding and resting habitat for fish.	Minor adverse	Minor adverse	None	Minor adverse	None
	Modification of intertidal feeding and subtidal habitat for fish	Negligible	Minor beneficial	None	Minor beneficial	None
	Change in feeding, resting and nursery	Negligible	Negligible	None	Negligible	None

Receptor	Effect	Significance of effect		Mitigation	Significance of residual effect	Compensation
		Year 1	Year 6			
	habitat for fish due to accretion					
	Interference with migratory movements of fish	Negligible	Negligible	None	Negligible	None
	Reduction in the occurrence of dissolved oxygen related fish mortalities.	Minor beneficial	Minor beneficial	None	Minor beneficial	None
	Increase in the distribution of pollution sensitive fish species.	Negligible	Minor beneficial	None	Minor beneficial	None
	Creation of new intertidal habitat	Minor beneficial	Minor beneficial	None	Minor beneficial	None
	Improvement in the quality of foraging habitat	Negligible	Minor beneficial	None	Minor beneficial	None
Invertebrates	Permanent loss of intertidal feeding and burrowing habitat for invertebrates.	Minor adverse	Minor adverse	None	Negligible	None
	Modification of intertidal and subtidal habitats for invertebrates by scour protection	Negligible	Negligible	None	Negligible	None
	Change to burrowing and feeding habitat due to accretion	Negligible	Negligible	None	Negligible	None
	Localised improvements in invertebrate diversity and abundance.	Negligible	Minor beneficial	None	Minor beneficial	None
	Creation of new intertidal habitat	Minor beneficia.	Minor beneficial	None	Minor beneficial	None
	Increase in the distribution of pollution	Negligible	Minor	None	Minor beneficial	None

Receptor	Effect	Significance of effect		Mitigation	Significance of residual effect	Compensation
		Year 1	Year 6			
	sensitive invertebrate species.		beneficial			
Algae	Permanent loss of the original river wall	Negligible	Negligible	None	Negligible	None
	Changes in algal communities	Minor beneficial	Minor beneficial	None	Minor beneficial	None
	Creation of additional habitat for algae	Minor beneficial	Minor beneficial	None	Minor beneficial	None

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Section 6: Ecology - terrestrial

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6 Ecology – terrestrial

6.1 Introduction

6.1.1 This section presents the findings of the assessment of the likely significant effects of the proposed development on terrestrial ecology at the Albert Embankment Foreshore site.

6.1.2 The proposed development has the potential to affect terrestrial ecology due to:

a. site and vegetation clearance, and subsequent reinstatement

b. temporary structures within the foreshore

c. construction and site activities

d. barge movements and associated facilities.

6.1.3 Operational effects for terrestrial ecology for this site have not been assessed. This is on the basis that permanent operational lighting is minimal and complies with the lighting design principles to minimise light spill, and maintenance works are limited to intermittent visits to site by maintenance personnel and vehicles. No significant operational effects are considered likely and for this reason, only construction effects are assessed.

6.1.4 The following are not considered within the assessment:

a. Contaminated runoff and atmospheric pollution, as these would be controlled through the implementation of the *Code of Construction Practice (CoCP)*[i].

b. Designated sites relevant to terrestrial ecology. This is because those that lie within 250m of the site are isolated from the site. No likely effects on these sites due to proposed construction works have been identified. However, the baseline includes details of the designated sites within 250m of the site (para. 6.4.2).

6.1.5 The assessment of the likely significant effects of the project on terrestrial ecology has considered the requirements of *the National Policy Statement (NPS) for Waste Water* (Defra, 2012)[1]. In line with these requirements, designations, species and habitats relevant to terrestrial ecology are identified and measures incorporated into the proposed development described. Based on assessment findings, measures to address likely significant adverse effects are identified. Vol 2 Section 6 provides further details on the methodology.

[i] The Code of Construction Practice (CoCP) is provided in Vol 1 Appendix A. It contains general requirements (Part A), and site specific requirements for this site (Part B).

6.1.6 Plans of the proposed development as well as figures included in the assessment for this site are contained in a separate volume (Volume 16 Albert Embankment Foreshore Figures).

6.2 Proposed development relevant to terrestrial ecology

6.2.1 The proposed development is described in Section 3 of this volume. The elements of the proposed development relevant to terrestrial ecology are set out below.

Construction

6.2.2 The following elements of the construction phase have the potential to affect terrestrial ecology receptors:

a. two options for construction access are assessed in this assessment: access via Lack's Dock (Option A) and access between Camelford House and Tintagel House (Option B). Option A would result in the pruning of introduced shrub and the removal of a small area of introduced shrub along Lack's Dock, which would be reinstated. Option B would result in removal of two trees and an area of amenity grassland and introduced shrub that would be reinstated

b. construction works throughout the construction phase that would create noise and vibration, such as the use of construction machinery and vehicles, demolition and the tunnel excavation. This includes noise and vibration for a limited period during 24 hour working

c. artificial lighting of the site in evenings during winter, and continuously during the construction and secondary lining of the connection tunnel

d. use of barges and the associated temporary campshed on the foreshore, and the subsequent reinstatement of the foreshore, including intertidal terraces.

Code of Construction Practice

6.2.3 The Code of Construction Practice *(CoCP)* is formed of Part A covering measures to be applied at all sites and Part B covering site specific measures. The *CoCP* Part A (Section 11) sets out the standards, procedures, and measures for managing and reducing construction effects. These measures would be implemented through a site specific *Construction environmental management plan* (*CEMP*), which would encompass an *Ecology and landscape management plan* (*ELMP*). The *ELMP* would include measures to protect and minimise impacts on sensitive ecological receptors such as designated sites, sensitive habitats (e.g. trees, scrub, watercourses, grassland), and notable species.

Part A

6.2.4 The *CoCP* Part A (Section 11) includes the following measures to reduce impacts on terrestrial ecology:

a. consultation with a suitably qualified ecologist in preparing the control measures within the *ELMP* and *CEMP*

b. a check of the site would be undertaken by an ecologist in advance of works to identify any ecological constraints in addition to those discussed in this *Environmental Statement*.

c. supervision of works by a suitably qualified ecologist

d. protection of trees

e. measures specific to bats such as the control of lighting, noise and vibration, and procedures to follow if a bat roost is present on site

f. measures to prevent harm to nesting birds and birds that are listed on Schedule 1 of the Wildlife and Countryside Act 1981 (WCA, 1981)

g. the use of capped and cowled lighting that is directed away from sensitive ecological receptors

h. controls to minimise noise and vibration, including use of noise enclosures, careful plant selection and careful programming of works

i. controls to site drainage to minimise the potential for pollution of watercourses and contamination of sensitive habitats

j. controls to prevent spread of non-native invasive plants, where present.

Part B

6.2.5 Site-specific measures contained in the *CoCP* Part B (Section11) for terrestrial ecology are detailed below.

a. protection of the river bed during construction and restoration of the foreshore after works

b. for Option B, where construction access would be between Camelford House and Tintagel House, replacement tree planting would be provided

c. protection of retained vegetation.

Environmental design measures

6.2.6 The following measures to minimise adverse effects or provide biodiversity enhancements have been incorporated into the project design:

a. replacement of vegetation removed along Lack's Dock during construction (access Option A only)

b. reinstatement of habitat on site at the end of construction in accordance with the proposed development description in this *Environmental Statement*, comprising the provision of replacement tree planting, with at least the same number of trees that have been removed during construction, reinstatement of amenity grassland and introduced shrubs

c. Three new semi-mature London Plane trees would be planted on the shaft structure

d. inter-tidal habitat would be provided on the terraces around the interception structure.

6.3 Assessment methodology

Engagement

6.3.1 Volume 2 Environmental assessment methodology documents the overall engagement which has been undertaken in preparing the *Environmental Statement*. Specific comments relevant to this site for the assessment of terrestrial ecology are presented in Vol 16 Table 6.3.1 below.

Vol 16 Table 6.3.1 Terrestrial ecology – stakeholder engagement

Organisation	Comment	Response
London Borough of Lambeth (scoping opinion letter, June 2011)	Acknowledge that the site is of limited if not poor ecological value, and highlight that there is potential to create new features or habitats (soft landscaping) on the operational site.	The scheme has included intertidal vegetated terraces at Albert Embankment Foreshore site. However, no other soft landscaping is proposed as the site is to be reinstated (para. 6.2.6)
	It will be important to monitor the site and any nearby sites that could be adversely affected to ensure that important habitats and species are not missed prior to construction.	Pre-start checks at all sites would be undertaken, as described in the *CoCP* (see 6.2.4 and 6.2.5). Any mitigation measures required at that time would be addressed.
	It will be essential to have effective mitigation plans and protocols in place to protect species and habitats if found on site.	General ecological mitigation and protection measures are included in the *CoCP* (para. 6.2.4)
	The above ground vehicle movements associated with the tunnelling works could have effects on terrestrial ecology.	The above ground vehicle movements associated with the tunnelling works are included in the assessment of effects when considering disturbance to wintering birds and bats (para.6.4.24).
London Borough of Lambeth (phase two consultation	The proposed combined sewer overflow (CSO) site will certainly physically impose upon the River Thames which is a	The effects of the proposed works on the River Thames SINC (Grade M) is being considered as part of the

Organisation	Comment	Response
response)	Metropolitan Site of Importance for Nature Conservation (SINC Grade M). The Council will want comfort right through the process that any impacts upon the SINC will be quantified and minimised.	aquatic ecology assessment (Section 5 of this volume).
Environment Agency (Section 48 consultation response 2 October 2012)	Para 15.3.8 The foreshore in this area is a large shoal area of gravel/shingle. It is rare in the local context and therefore it will need to be reinstated fully once the coffer dam and campsheds are removed.	There will be some permanent loss of foreshore habitat and this loss has not been entirely avoidable through the design of the in-river structure. Inter-tidal terraces will also include gravel substrate..

Baseline

6.3.2 The baseline methodology follows the methodology described in Vol 2 Section 6. In summary, the following baseline data has been reported in this assessment:

a. desk study

b. a Phase 1 Habitat Survey was undertaken on 9 December 2010

c. bat triggering surveys (remote recording surveys) were undertaken over three nights between 6 and 8 May 2011

d. wintering bird surveys were undertaken on 16 December 2010 and 25 January, 24 February, 28 March, 17 October and 29 November 2011.

Construction

6.3.1 The assessment methodology for the construction phase follows that described in Vol 2 Section 6. There are no site specific variations for this site. All likely significant effects throughout the duration of the construction phase are assessed.

6.3.2 The term significance is used within this volume to refer to project significance levels from negligible to major effects (adverse and beneficial). Adverse moderate or major effects are considered to be significant and require mitigation, and negligible and minor effects are not considered significant and therefore do not require mitigation. These significance criteria and their relationship with levels of significance are based on the *Institute for Ecology and Environmental Management guidelines (*IEEM, 2006)[2] is given in Vol 2 Section 6.

6.3.3 No effects on habitats are predicted beyond 10m of the site boundary. Therefore, the assessment area comprises the site and adjacent land within 10m of the site boundary.

6.3.4 The assessment considers bats and wintering birds within 100m of the site. This is considered to be a sufficient distance within the context of the urban environment to ensure that any significant effects on species, for example from disturbance as a result of construction lighting and noise, are assessed.

6.3.5 Section 6.5 details the likely significant effects arising from the construction at the Albert Embankment Foreshore site. There are no other Thames Tideway Tunnel project sites which could give rise to additional effects on terrestrial ecology within the assessment area for this site, therefore no other Thames Tideway Tunnel project sites are considered in this assessment.

6.3.6 No change to the base case conditions for terrestrial ecology are considered likely from the proposed developments listed in Vol 16 Appendix N, due to the isolated location of these developments from the proposed development site, within the urban context.

6.3.7 No significant cumulative effects for terrestrial ecology are considered likely the proposed developments listed in Vol 16 Appendix N, due to the isolated location of these developments from the proposed development site, within the urban context.

6.3.8 The assessment of construction effects considers the extent to which the assessment findings would be likely to be materially different, should the programme for the Thames Tideway Tunnel project be delayed by approximately one year.

Assumptions and limitations

6.3.9 The assumptions and limitations associated with this assessment are presented in Vol 2 Section 6. Site specific assumptions and limitations are detailed below.

Assumptions

6.3.10 It is assumed for the purposes of assessment that the current use of the Albert Embankment Foreshore site (described in Vol 16 Section 2) will continue between the time of ecological surveys and Site Year 1 of construction.

Limitations

6.3.11 No site-specific limitations have been identified.

6.4 Baseline conditions

6.4.1 The following section sets out the baseline conditions for terrestrial ecology receptors within and around the site, including their value. Future baseline conditions (base case) are also described. All figures referred to in this section are contained in the Vol 16 Albert Embankment Foreshore Figures.

Current baseline

Designated sites

6.4.2 Albert Embankment Foreshore lies within the River Thames Tidal Tributaries Site of Importance for Nature Conservation (SINC Grade III of Metropolitan importance[ii]). This is shown on Vol 16 Figure 6.4.1 (see separate volume of figures). The effects on this site are assessed by the aquatic ecology assessment (Section 5 of this volume) and are not considered any further in this assessment

Habitats

6.4.3 Habitats recorded within the survey area during the Phase 1 Habitat Survey are described in Vol 16 Table 6.4.1 below and shown on Vol 16 Figure 6.4.2 (see separate volume of figures).

Vol 16 Table 6.4.1 Terrestrial ecology – Phase 1 Habitat Survey

Habitat type	Habitat description
Hardstanding and river wall	There is an area of hardstanding and river wall adjacent to the River Thames, within the site boundary.
Amenity grassland	Amenity grassland is present on and adjacent to the site in the northeast of the survey area, adjacent to the River Thames.
Scattered trees	Scattered trees, which have been planted for ornamental purposes, are present on and adjacent to the site along the southeast site boundary, and also to the northeast of the survey area.
Introduced shrub	There is a row of introduced shrub along Lacks Dock slipway, an area within amenity grassland on site. There is also a strip of introduced shrub along the eastern survey boundary, adjacent to an area of amenity grassland.
Running water and intertidal habitat	The majority of the survey area lies within the River Thames in the intertidal zone. This habitat type is part of the aquatic ecology assessment (Section 5 of this volume).

6.4.4 The hardstanding and river wall are not considered to have biodiversity value as habitat and therefore are of negligible value.

6.4.5 The scattered trees on and immediately adjacent to the site boundary are semi-mature and planted for ornamental purposes. These trees have not been given any specific ecological designation and are not listed on the

[ii] SINC (Grade M) = Site of Importance for Nature Conservation (Grade III of Metropolitan importance)

local Biodiversity Action Plan (BAP). They are considered to be of low (site) value.

6.4.6 The amenity grassland is limited in extent, species poor and can be easily recreated. Therefore, this habitat is considered to be of negligible value.

6.4.7 The introduced shrub on site is considered to provide limited value as a habitat type. Therefore, the introduced shrub habitat is considered to be of negligible value.

Notable species

6.4.8 Survey results are set out in a notable species report, which is included in Vol 16 Appendix D.1. A summary of the results and an assessment of the value of species associated with the site are set out below.

Bats

6.4.9 The Phase 1 Habitat Survey identified that the abutments of Vauxhall Bridge have the potential to be used by bats for roosting. The potential for bats to forage and commute along the River Thames was also identified during the Phase 1 Habitat Survey. Therefore, remote recording surveys were undertaken for bats.

6.4.10 All bats are European Protected Species (EPS) under the Conservation of Habitats and Species Regulations 2010. Seven of the 18 bat species that regularly occur in England are listed as priority species on the UK BAP. Nine bat species are listed on the London BAP including common pipistrelle (*Pipistrellus pipistrellus)* and soprano pipistrelle (*Pipistrellus pigmaeus*). These two species were recorded on site. Detailed survey results are provided in Vol 16 Appendix D.1 and on Vol 16 Figure 6.4.3 (see separate volume of figures).

6.4.11 The common pipistrelle bat is the UK's most common bat species, and is a widespread species in Greater London. Soprano pipistrelle bat is also widespread and common across Greater London but has a smaller UK population than the common pipistrelle (London Bat Group, 2012)[3], (Harris *et al.*, 1995)[4]. Both species are in decline mainly due to habitat loss.

6.4.12 During the remote recording surveys, the maximum number of common pipistrelle bat passes recorded in one night was 13 (6 May 2011). No bat passes were recorded close to sunset or sunrise when bats leave and return to their roost sites, indicating that the movement was unlikely to be associated with a nearby roost. The bats are considered likely to have been commuting and foraging along the River Thames and along the tree line on and adjacent to the site.

6.4.13 Only one soprano pipistrelle bat pass was recorded during the remote recording survey (6 May 2011). This suggests that soprano pipistrelle bats occasionally commute through the site or forage on and adjacent to the site.

6.4.14 With consideration given to the conservation status of both common pipistrelle and soprano pipistrelle, and the size of the populations using the site relative to their UK populations, the populations of these two species associated with the site and its immediate surrounds are considered to both be of low (site) value.

Breeding birds

6.4.15 During the Phase 1 Habitat Survey, the trees, scattered scrub and tall ruderal vegetation adjacent to the site were considered to provide a foraging and nesting resource for birds, although the quality of the habitat was considered to be sub-optimal to support a notable population or assemblage of species that would require a breeding bird survey to be undertaken.

6.4.16 Birds that are likely to be nesting within vegetation on and adjacent to the site are likely to comprise bird species common to the area, including some that are listed as London and UK BAP priority species (see desk study in Vol 16 Appendix D.1). However, the number of nests that the vegetation could support is considered to be small. The bird resource on site is therefore considered to be of low (site) value.

Wintering birds

6.4.17 During the Phase 1 Habitat Survey, the foreshore habitat along the River Thames, comprising intertidal sands and silts, was considered to have potential for wintering bird species and wintering bird surveys were therefore undertaken at the site. Details of the wintering bird survey are provided in Vol 16 Appendix D.1 and shown on Vol 16 Figure 6.4.4 (see separate volume of figures).

6.4.18 A total of nine waterbird species were recorded on the foreshore both on and adjacent to the site. Of these waterbird species, six are of nature conservation importance and are included on the Birds of Conservation Concern 3 (RSPB, 2009)[5] Red or Amber List[iii] and/or UK and London BAP as priority species (Vol 16 Table 6.4.2).

6.4.19 Mallard (*Anas platyrhynchos)*, black-headed gull (*Chroicocephalus ridibundus)*, common gull (*Larus canus),* lesser black-backed gull (*Larus fuscus)*, herring gull (*Larus argentatus)* and great black-backed gull (*Larus marinus*) were recorded foraging on inter-tidal mud and along the water's edge on and adjacent to the site.

[iii] The conservation status of all regularly occurring British birds has been analysed in co-operation with the leading governmental and non-governmental conservation organisations, including the Royal Society for the Protection of Birds (RSPB), British Trust for Ornithology (BTO) and Birdlife International Birds of Conservation Concern 3 (RSPB, 2009). The basis of species ongoing population trends are assigned to one of three lists of Conservation Concern. These are the UK Red, Amber and Green lists. Although the lists confer no legal status in themselves, they are useful in evaluating the conservation significance of bird assemblages, and for assessing the potential significance of impacts and informing appropriate levels of mitigation with respect to bird populations.

Birds of Conservation Concern (BoCC) Red List criteria for breeding birds are those which have experienced a severe decline of more than 50% of population and / or range over the last 25 years, as measured by the number of 10km squares occupied by breeding birds of the species concerned. Species listed as globally threatened by Birdlife International and those with a historical decline in the UK between 1800 and 1995 (without evidence of recovery) are also included. BoCC Amber List criteria for breeding birds are those which have experienced a moderate decline of between 25% and 49% of population and / or range over the last 25 years. Species of European conservation concern and those with a historical decline but which are currently recovering are also included.

6.4.20 The records of waterbirds of nature conservation importance recorded on the foreshore on and adjacent to the site were compared to counts at other sites published in the *London Bird Report 2007 (*London Natural History Society, 2011)[6]. All waterbird species associated with the foreshore habitat were recorded at low numbers relative to their London populations (*London Bird Report, 2007*). However, the six species of conservation importance appreciably enrich the local biodiversity resource, and are each considered to be of low-medium (local) value. The remaining three waterbird species that are not of nature conservation importance are considered to be of low (site) level.

Vol 16 Table 6.4.2 Terrestrial ecology – wintering waterbirds of nature conservation importance

Common name	Latin name	Nature conservation designation	Maximum counts	Value
Mallard	*Anas platyrhynchos*	Amber List	Recorded on each visit, with a maximum count of 17 in December 2010 and numbers varying between two and five in other months.	Low-medium (local)
Black-headed Gull	*Larus ridibundus*	Amber List	Recorded on each survey visit apart from March 2011, with a maximum count of 150 in November 2011 and numbers varying between 102 and 134 in other months.	Low-medium (local)
Common Gull	*Larus canus*	Amber List	Recorded on four survey visits, with a maximum count of nine in February 2011 and three in other months.	Low-medium (local)
Lesser Black-backed Gull	*Larus fuscus*	Amber List	Recorded on each survey visit, with a maximum count of 12 in March 2011 and numbers varying between three and seven in other months.	Low-medium (local)

Common name	Latin name	Nature conservation designation	Maximum counts	Value
Herring Gull	*Larus argentatus*	Red List and UK and London BAP Priority List	Recorded on each survey visit, with a maximum count of 35 in October 2011 and numbers varying between four and 23 in other months.	Low-medium (local)
Great Black-backed Gull	*Larus marinus*	Amber List	Two individuals were recorded in November 2011.	Low-medium (local)

Noise, vibration and lighting

6.4.21 As noise, vibration and lighting have the potential to disturb species both on and adjacent to the site, baseline conditions are described here.

6.4.22 Current sources of noise and vibration (Section 9 of this volume) are associated with vehicle movement from adjacent roads to the south and east of the site.

6.4.23 At night, the area receives relatively high levels of light spill from street and security lighting adjacent to the site.

Construction base case

6.4.24 Assuming use of the site continues as at present, conditions on site at Site Year 1 of construction would be the same as the current ecological baseline conditions.

6.4.25 The noise and vibration base case is described in detail in Section 9 of this volume. Noise levels are likely to be similar to those currently present on and in close proximity to the site, with slight increases in noise experienced due to an anticipated increase in traffic levels adjacent to the site. The levels of vibration around the site are considered unlikely to change between the present time and the base case.

6.4.26 The light levels are likely to be similar to current light levels on site.

6.5 Construction effects assessment

Construction impacts

Habitat clearance and creation

6.5.1 A section of river wall of negligible value which lies within the site boundary would be removed as part of the site clearance activities. It is proposed that this would be replaced with a new, extended section of river wall.

6.5.2 There would be a temporary loss of foreshore habitat for wintering birds during construction. A small area of foreshore would be permanently lost to the structure proposed within the foreshore. The permanent structure would include an intertidal terrace, which is likely to provide resting habitat for wintering birds.

Option A: Access via Lack's Dock

6.5.3 A small area of introduced shrub of negligible value along the slipway would be pruned and removed. Tree protection measures would be in place to prevent impacts on trees adjacent to the site, as detailed in the *CoCP* Part A (Section 11). Replacement planting would be provided for vegetation removed.

Option B: Access between Camelford House and Tintagel House

6.5.4 Two trees of low (site) value, and introduced shrub and amenity grassland of negligible value would be removed during site clearance. Tree protection measures would be in place to prevent impacts on trees adjacent to the site, as detailed in the *CoCP* Part A (Section 11). Replacement tree planting would be provided including three trees on the permanent operational structure.

Movement, noise, vibration and lighting

6.5.5 An increased level of activity is anticipated on site due to the movement of site personnel and vehicles. Noise and vibration impacts are based upon the data and assessment in Section 9 of this volume. Noise levels are predicted to be higher than the ambient noise levels throughout the construction period with works taking place during the day and night during construction. There may be occasional sudden noises on site created by the movement of materials or the starting of vehicles. Vibration levels are likely to increase during construction. This could disturb wintering birds.

6.5.6 Construction would require there to be some lighting in the early morning and evening during the winter months to facilitate the extension of standard working hours. There would also be periods where lighting is required to facilitate 24 hour working. Given the high background light levels at this location and with measures as detailed in the *CoCP* Part A (Section 4) implemented at this site, light spill from construction lighting would be minimal. Therefore, disturbance from construction lighting is unlikely to disturb wintering birds and bats.

6.5.7 As no bat roosts have been identified, bats are only likely to be present within habitat adjacent to the site whilst foraging and commuting at night. Foraging and commuting bats are unlikely to be affected by the increases in noise and vibration levels, and movements of vehicles at night.

Barging and associated facilities

6.5.8 The use of campsheds would result in the temporary loss of habitat for wintering birds and bats on the foreshore of the River Thames. The foreshore would be reinstated following removal of the campsheds at the end of construction.

6.5.9 Although light spill would be minimised through measures in the *CoCP* Part A (Section 4), some increases in lighting are expected on the foreshore as a result of lighting of the barging facilities for navigational purposes. Therefore, some disturbance from lighting is anticipated on wintering birds and commuting bats.

6.5.10 The movement of barges in and out of the site is likely to cause disturbance to wintering birds on the foreshore adjacent to the site. Wash created by the movement of barges may also displace birds from the foreshore adjacent to the site.

Construction effects

Habitats

Option A: Access via Lack's Dock

6.5.11 The loss of a small area of introduced shrub, hardstanding and river wall of negligible value with replacement planting is considered probable to be **negligible** and not significant.

Option B: Access between Camelford House and Tintagel House

6.5.12 The loss of two trees of low (site) value, and hardstanding, river wall, introduced shrub and amenity grassland of negligible value with replacement planting is considered unlikely to perceptibly change the local habitat resource. Therefore, the effect is considered to be probable, **negligible** and not significant.

Notable species

Bats

6.5.13 There would be temporary loss of a small area of foreshore habitat for bats, which is likely to result in displacement of bats to adjacent habitat along the River Thames foreshore. The displacement is not considered likely to affect the local bat populations. The effect is considered to be probable, **negligible** and not significant.

6.5.14 As there are currently no roosts on or adjacent to the site, there would be no disturbance to roosting bats. The presence of the barge facilities and small changes in light levels as a result of navigational lighting are unlikely to create a barrier to the movement of commuting bats given the existing high background light levels. Common and soprano pipistrelle bats can tolerate relatively high light levels, up to 14 lux. Noctule bats tend to fly high, only occasionally moving closer to the ground to forage. Noctule bats are therefore considered unlikely to be affected by light spill at the level of the river. There may be slight changes in bat behaviour as bats would need to commute over or around the barge facilities. The River Thames is a wide corridor and the function of this habitat is likely to be maintained. It is considered unlikely that changes in light levels and changes in commuting behaviour would have an effect on the local distribution and abundance of bat populations. Therefore, the effect is considered to be probable, **negligible** and not significant**.**

Breeding birds

6.5.15 There would be the temporary loss of a limited area of breeding bird habitat on site with both access Option A and B. The change in habitat is considered unlikely to result in perceptible changes in breeding bird populations. The small numbers of nesting birds associated with the site are likely to be displaced to alternative habitat in the wider area. The effect of temporary habitat loss is considered to be probable, **negligible** and not significant.

6.5.16 Any birds adjacent to the site are likely to habituate to small changes in noise and vibration levels and disturbance from lighting would be minimal. Suitable habitat is available within the wider area, and any birds displaced could move to these areas. Any change in populations would not be perceptible against background populations. Therefore, the effect on breeding birds of disturbance is considered to be probable, **negligible** and not significant.

Wintering birds

6.5.17 Works within the foreshore would result in the loss of foreshore habitat for wintering waterbirds during construction. It is considered likely that the small number of waterbirds that use the site for foraging and resting would be displaced to other areas of foreshore adjacent to the site and in the wider area. The area of foreshore that would be permanently lost to the operational structure is small relative to the area of foreshore that would remain available for foraging and resting wintering birds within the River Thames. Following reinstatement of the majority of the foreshore, wintering birds are likely to return to the site. No perceptible change in wintering bird populations associated with the site are anticipated. The intertidal terraces are likely to provide a small resting area for wintering birds but are unlikely to result in any change to wintering bird populations. Therefore, the effect on wintering bird populations of habitat loss at the site is considered to be probable, **negligible** and not significant.

6.5.18 There would be a small temporary increase in noise, vibration and lighting levels. It is considered unlikely that waterbirds from the River Thames adjacent to the site would be displaced. Occasional displacement of birds is expected where sudden noises occur and when barges pass close by, with small numbers of wintering birds from adjacent intertidal habitat temporarily moving away from the habitat and returning shortly after. This displacement and return of wintering birds has been observed on the foreshore at other sites on the Thames, particularly where people walk along the foreshore. It is considered unlikely that this displacement would result in a perceptible change in wintering bird populations. Therefore, the effect of disturbance on wintering bird populations is considered to be probable, **negligible** and not significant.

Sensitivity test for programme delay

6.5.19 For the assessment of effects on terrestrial ecology during construction, a delay to the Thames Tideway Tunnel project of approximately one year would not be likely to materially change the assessment findings reported above (paras. 6.5.1 - 6.5.18). This is because there are no developments in the site development schedule (see Vol 11 Appendix N) that would fall into the base case as a result of this delay and therefore the base case would remain as described in paras. 6.4.24 - 6.4.26.

6.6 Operational effects assessment

6.6.1 As stated in para. 6.1.3, operational activities are limited at this site and not likely to lead to significant operational effects.

6.7 Cumulative effects assessment

Construction effects

6.7.1 There are no developments in the vicinity of Albert Embankment Foreshore site to be considered in the cumulative effects assessment. Therefore the effects on terrestrial ecology would remain as described in para. 6.4.24.

Sensitivity test for programme delay

6.7.2 In the event that the programme for the Thames Tideway Tunnel project is delayed by approximately a year, the cumulative effects assessment would remain unchanged. As described above in para. 6.7.1, there are no schemes anticipated to generate cumulative effects on terrestrial ecology and this would remain the case with a programme delay of approximately one year.

6.8 Mitigation

6.8.1 All measures embedded in the design and the *CoCP* Part A (Section 11) of relevance to terrestrial ecology are summarised in Section 6.2. As no significant adverse effects have been identified, no other mitigation measures for construction are proposed.

6.9 Residual effects assessment

Construction effects

6.9.1 As no mitigation measures are proposed, the residual construction effects remain as described in Section 6.5. All residual effects are presented in Section 6.10.

6.10 Assessment summary

Vol 19 Table 6.10.1 Terrestrial ecology – construction assessment summary

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Habitats				
Trees, introduced shrub, amenity grassland, hardstanding and river wall.	Option A: No significant change in habitat on site as the habitats to be removed are considered to be of negligible value.	Negligible	None	Negligible
	Option B: No significant change in the local habitat resource as trees of low (site) value would be replaced following completion of works.	Negligible	None	Negligible
Notable species				
Bats	No significant change in bat populations as a result of temporary and permanent changes to the commuting and foraging habitat along the foreshore on site due to construction works within the foreshore, and the presence of a permanent operational structure within the foreshore.	Negligible	None	Negligible
	No significant changes to bat populations as a result of disturbance from small increases in light levels and works within the foreshore.	Negligible	None	Negligible
Breeding birds	No significant change in breeding bird populations as a result of temporary loss of nesting habitat on site.	Negligible	None	Negligible
	No significant change in breeding bird populations as a result of temporary disturbance from small changes in noise, vibration and	Negligible	None	Negligible

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
	lighting levels.			
Wintering birds	No significant changes in wintering bird populations due to temporary and permanent loss of resting and foraging habitat within the foreshore habitat on site.	Negligible	None	Negligible
	No significant changes in populations of wintering birds as a result of disturbance from noise, vibration, lighting and the movement of barges.	Negligible	None	Negligible

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.16**

Volume 16: Albert Embankment Foreshore site assessment

Section 7: Historic environment

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Thames Tideway Tunnel

Environmental Statement

Volume 16: Albert Embankment Foreshore site assessment

Section 7: Historic environment

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7 Historic environment

7.1 Introduction

7.1.1 This section presents the findings of the assessment of the likely significant effects of the proposed development on the historic environment at the Albert Embankment Foreshore site. The historic environment is defined in para. 4.10.2 of the NPS as including all aspects of the environment resulting from the interaction between people and places through time, including all surviving physical remains of past human activity, whether visible, buried or submerged, and landscaped and planted or managed flora. For the purposes of this assessment, heritage assets comprise below and above-ground archaeological remains, buildings, structures, monuments and heritage landscapes within and around the site. Effects during construction and operation are assessed with effects on buried assets presented first, followed by above-ground assets.

7.1.2 Based on a review of the noise and vibration assessment (Section 9), it is concluded that there would be no significant noise or vibration effects requiring offsite mitigation to any listed building. Such effects are therefore not considered further in this assessment.

7.1.3 Once the proposed development is operational, scour protection around foreshore structures would prevent scour affecting heritage assets. In the deeper mid channel of the river, where contraction scour may occur, it is considered unlikely that archaeological remains would be present. The operational phase would not involve any activities below-ground aside from maintenance confined within the tunnel infrastructure. For these reasons, an assessment has not been undertaken of operational effects on buried assets.

7.1.4 An undesignated prehistoric site of high heritage significance has been identified in and adjacent to the site on the Thames foreshore, containing numerous artefacts and objects dated to the Mesolithic and Neolithic periods. An assessment of effects on this asset has been undertaken.

7.1.5 The construction assessment includes an assessment of the effects of ground movement generated by tunnelling and deep excavations (in this case ground settlement). As the ground movement would be generated by construction activity and any damage would be greatest for the period of construction, an assessment has not been undertaken of operational effects on above ground heritage assets from ground movement. An assessment of effects from ground movement resulting from the whole Thames Tideway Tunnel project is covered in Vol 3 Project wide effects.

7.1.6 The assessment of the historic environment effects of the project has considered the requirements of the *National Policy Statement for Waste Water* (NPS). As such the assessment covers designated and non-designated assets, and a description of the significance of each heritage asset affected by the proposed development and the contribution of their setting to that significance. The assessment covers both above and below ground assets. The effect of the proposed development on the significance of heritage assets is clearly detailed in line with the requirements of the NPS. The role of the design process in helping to minimise effects on the historic environment is explained, and where appropriate, mitigation is proposed. Vol 2 Section 7 provides further details on the methodology.

7.1.7 A separate but related assessment of effects on townscape character and visual amenity is included in Section 11 Townscape and visual.

7.1.8 Plans of the proposed development as well as figures included in the assessment for this site are contained in a separate volume (Volume 16 Albert Embankment Foreshore Figures).

7.1.9 Two access options have been considered: Option A is via Lack's Dock and Option B involves the construction of a temporary road access between Camelford House and Tintagel House. There would be no material difference in terms of effects on the historic environment, because the two options would not affect buried heritage nor would they have different effects on the setting of historic environment receptors. Therefore the options are not presented or reported separately for this topic.

7.2 Proposed development relevant to the historic environment

7.2.1 The proposed development is described in Section 3 of this volume. The elements of the proposed development relevant to the historic environment are set out below.

Construction

7.2.2 All below-ground works during construction are relevant to the assessment because they would potentially truncate or entirely remove any archaeological assets within the footprint of the works. Those in the vicinity of the listed Vauxhall Bridge would cause ground movement that could potentially induce damage to the listed bridge. Below ground works are described below.

7.2.3 Site fencing would be erected, supported by timber posts in concrete foundations. Welfare facilities would be constructed over part of the Thames Path assumed for the purposes of this assessment to be set on foundations with a depth of up to approximately 1.0mbgl. The site set-up would also entail the construction of new service trenches up to approximately 1.5m deep (see Construction phase 1 plan, separate volume of figures - Section 1).

7.2.4 The existing early 20th century sewage outfalls would be demolished, including scour protection aprons and associated timber dolphins and timber posts (see Demolition and site clearance plan 1, separate volume of figures - Section 1).

7.2.5 Two temporary cofferdams would be built on the Thames to provide a construction working area. Access to the southern cofferdam would be via a ramp built on the foreshore from the western end of the Lack's Dock slipway. Access to the northern cofferdam during construction works would be either from Lack's Dock on the southern side of Camelford House (Option A) or from a temporary access route between Camelford House and Tintagel House (Option B) from the Albert Embankment to the north. Access to the permanent works within the northern cofferdam would be from Lack's dock (see Access plan, separate volume of figures - Section 1).

7.2.6 Demolition works would require the removal of the parapet of part of the unlisted river wall to the north of Lack's Dock, and the removal of the parapet on one bay of the river wall to the south of Lack's Dock. Connection of the new structures to the existing river walls may require localised removal of parts of the fabric of the lower structure of the wall (see Demolition and site clearance plan, separate volume of figures - Section 1). If access Option B (between Camelford House and Tintagel house) is utilised, the section of the parapet to be removed would be approximately 7m longer than if access Option B is utilised (see Demolition and site clearance plan 2, separate volume of figures - Section 1).

7.2.7 A small section of dockside concrete wall within Lack's Dock would be removed, with the majority of it being replaced. An area of planting to the north of Lack's Dock would also be removed and replaced (see Demolition and site clearance plan 2, separate volume of figures - Section 1). This would be done to facilitate access to the northern cofferdam during construction works if that route was chosen or to facilitate access to the permanent works there after construction.

7.2.8 For structural reasons, soft material located adjacent to the perimeter of the temporary cofferdams and adjacent to the river wall would be removed. The soft material includes silt, peat and other materials. It is assumed for the assessment that the majority of foreshore material within the temporary cofferdams would remain *in situ*. Removal of the soft material would ensure that any ground movement of the cofferdam fill material does not adversely affect the ties between the walls of the twin walled temporary cofferdams leading to structural difficulties. All soft material within the permanent cofferdam would be removed to ensure sound foundations for permanent construction. The exact extent and depth of the foreshore deposits to be removed at each site would be informed by geotechnical investigations. Areas of removed material would be filled with gravel similar to the existing bed material. Cofferdam fill material would then be placed onto the foreshore on top of a geotextile layer, to a total average depth of 4.6m in the northern cofferdam and 4.8m in the southern cofferdam, as assumed for the purposes of this assessment. Suitable sized plant would be utilised to reduce potential load impacts on the foreshore. The cofferdam would be tied into the existing river wall using slots prepared in the river wall (see Demolition and site clearance plan; Construction phase 1 plan, separate volume of figures - Section 1).

7.2.9 The cofferdams would be constructed using a piling rig positioned on a jack-up barge located in the River Thames in the foreshore. The supports of the jack-up barge would sit on the river bed and extend into the foreshore deposits. Surface dewatering wells would be constructed within the cofferdam (see Construction phase 1 plan, separate volume of figures - Section 1). Upon removal of the temporary cofferdam, the fill and geotextile layer would be removed by suitably sized plant and the locally excavated areas on the foreshore would be reinstated with suitable material to match the pre-existing river conditions.

7.2.10 The permanent foreshore structures would be built within the temporary cofferdams. A campshed is proposed for the delivery and removal of materials by barge and would be constructed on the Thames foreshore adjacent to the northern cofferdam. Foreshore material would be removed from within the footprint of the campshed to a depth of approximately 0.3m, as assumed for the purposes of this assessment. The area of the foreshore where permanent scour protection is required would be excavated to a depth of approximately 1.5m by an excavator.

7.2.11 The permanent works would include an outfall apron, along with deep excavations for the construction of a combined sewer overflow (CSO) drop shaft and connection culverts linking the interception chamber to the CSO, and the CSO to the main tunnel. All other permanent works would be contained within the cofferdam fill material (see Construction phase plan 2 and 3 plans, separate volume of figures - Section 1).

7.2.12 The southern permanent foreshore structure would adjoin (and not be fixed to) the abutment of Vauxhall Bridge (see Proposed listed structure interface - interception structure plan and Proposed landscape plan, separate volume of figures - Section 1).

7.2.13 The construction activities which would give rise to effects on the historic character, appearance and setting of heritage assets are:

a. the temporary cofferdam structures

b. establishment of hoardings around the boundary of the construction site

c. use of cranes and other plant during construction

d. provision of welfare facilities

e. lighting of the site when required.

Code of Construction Practice

7.2.14 The *CoCP* is provided in Vol 1 Appendix A. It contains general requirements (Part A), and site specific requirements for this site (Part B).

7.2.15 Measures incorporated into the *Code of Construction Practice* (*CoCP*) Part A (Section 12) to protect heritage assets include:

a. The requirement for the contractor to prepare a site-specific *Heritage Management Plan* (HMP), indicating how the historic environment is to be protected. This may take form of both physical protection and working practices. It would also address any effects from third-party impacts, vibration, ground movement and dewatering.

b. Protective measures, such as temporary support, hoardings, barriers, screening and buffer zones around heritage assets, and archaeological mitigation areas within and adjacent to worksites.

c. Advance assessment to inform the types of plant and working methods for use where heritage assets are close to worksites, or attached to structures that form parts of worksites.

d. Where elements to be demolished are attached to listed structures being retained, they will be separated where practicable, prior to demolition, using non-vibratory techniques such as diamond sawing.

e. Care would be taken when jack-up barges; piling or borehole rigs; mechanical excavators or other plant is operating over areas of the river channel or foreshore known to be particularly archaeologically sensitive. In exceptional cases exclusion zones may apply. Safeguards may include appropriate methods for installing and operating plant, and the use of suitable foreshore protection.

f. Condition surveys to define ground movement and vibration limits for heritage assets potentially affected by the works - to include monitoring regimes and provision for cessation of works where feasible, should levels exceed the specified limits.

g. Procedures under EPP for the emergency repair of damage to listed buildings. Where there is damage that does not require emergency repair, repair will be affected as making good as part of the construction process. Final repairs to significant finishes would be 'like for like'.

h. Security procedures to prevent unauthorised access to heritage assets and archaeological investigations, and damage to or theft from them, including by the use of metal detectors.

i. Procedures in the event of the discovery of human remains.

j. Procedures under the Treasure Act Code of Conduct 1997, to address the discovery of any artefacts defined in the Treasure Act 1996.

7.2.16 Section 13 of the *CoCP* details the approach to third party impact and the asset protection process in relation to ground movement. This includes measures for the contractor to undertake a condition survey of the relevant infrastructure and buildings prior to commencing works that could impact them. The contractor would put in place protection measures during construction to minimise the impact to third-party infrastructure and buildings as a result of ground movement. Monitoring would be carried out prior to commencement of construction work to enable baseline values to be established and would continue until ground movement due to the works, as shown by the monitoring, has effectively ceased. Post condition surveys would be carried out, as well as installation of instrumentation and monitoring to confirm that ground movements is as predicted and acceptable. An Emergency Planning and Response Plan would be developed in conjunction with the asset owner to include relevant contingency plans and trigger levels for action.

7.2.17 Site-specific measures incorporated in the *CoCP* Part B (Section 12) include the requirement for contractors working methods to minimise risk of accidental striking the Grade II* listed Vauxhall Bridge. Protection barriers would be installed as required but would not be attached to the structure unless otherwise agreed.

7.2.18 All the measures detailed above form part of the proposed development subject to the assessment, and therefore impacts such as strike damage on heritage assets are considered unlikely to occur and are not assessed. However, site specific measures to mitigate effects on buried heritage, which would be detailed in *Site Specific Archaeological Written Scheme of Investigation (SSAWSI)*, in line with the *Overarching Archaeological Written Scheme of Investigation (OAWSI)* (Vol 2 Appendix E.2), would be subject to the findings of field evaluation, and are therefore reported as mitigation as detailed further in para. 7.8.6.

Operation

7.2.19 The operation of the proposed development at the Albert Embankment Foreshore site is described in Section 3 of this volume. The particular components of importance to this topic include the design of the public realm and the design and siting of the proposed ventilation structure and electrical kiosk.

7.2.20 The operational design has been developed through close liaison with stakeholders, including the local authority and English Heritage, and in response to early iterations of the environmental impact assessment, through a series of design workshops, as well as in response to other design factors, such as operational requirements. The design process has therefore helped to minimise effects on the character, appearance and setting of heritage assets. Such design decisions are 'embedded' within the proposed development which has been assessed. Alternatives to the proposed development, including design iterations, are fully detailed in Section 3 of this volume.

Historic environment design measures

7.2.21 A high quality design in keeping with the character of the surrounding townscape has been proposed for the development of this site to minimise adverse effects on the historic character, appearance setting of heritage assets in accordance with the design principles set out in Vol 1 Appendix B. Generic design principles of relevance to the historic environment at this site include:

a. All the principles for the integration of functional components including those relating to materials, the use of signature designs and careful detailing because they would inform the appearance of the completed operational infrastructure at the site.

b. All the heritage design principles. These set out measures to safeguard heritage significance and to develop designs and carry out works that are in accordance with established conservation principles and that also have regard to the interest of neighbouring heritage assets.

c. All the riparian and in-river structure principles regarding appearance and functionality that are relevant to the site.

d. All the landscape principles that apply at the site. These relate to the quality of soft and hard landscaping, materials and public accessibility.

e. All the lighting design principles that apply at the site relating to heritage and sensitive settings. These include matters relating to safety, the aesthetic effect of the lighting and the quality of fittings.

7.2.22 The following site-specific design principles are also relevant:

a. Any planting along Lack's Dock lost during construction would be replaced.

b. The design would respect the character and setting of the Grade II* listed Vauxhall bridge and the top of the interception structure (excluding vent columns) would be below the springing point of the bridge arch. The maintenance access gate would be the same height as the handrail on the existing river wall.

c. The inter-tidal terraces would have minimum fixings into the listed bridge abutment, and have an attractive appearance in an un-vegetated state.

d. The main electrical and control kiosk (interception structure) would be located in the secure area below the bridge and not attached to the listed bridge.

e. Secure fencing to the area below the bridge would be reinstated to match the existing like-for-like.

f. Seating would be positioned to maximise views of the Palace of Westminster World Heritage Site.

g. Existing paving in front of the Vauxhall Cross route would be reinstated in accordance with the landscape scheme for the restoration of the site. Paving to the top of the interception chamber and shaft structures would reference the lost River Effra and be attractive when viewed from the bridge above.

h. Interpretive materials and information on the views and historic interest of the site would be incorporated.

i. The new river walls to the interception chamber and shaft structures would be finished in high quality fair-faced concrete.

j. Paving to the top of the interception structure would be imaginatively designed to reference the lost River Effra and to be attractive when viewed from the bridge above.

7.3 Assessment methodology

Engagement

7.3.1 Volume 2 Environmental assessment methodology documents the overall engagement which has been undertaken in preparing the *Environmental Statement*. Specific comments relevant to this site for the assessment of the historic environment are presented here. Throughout the environmental impact assessment (EIA) there has been regular liaison with English Heritage and other stakeholders. Vol 16 Table 7.3.1 below summarises the comments raised by consultees and how each comment has been addressed.

7.3.2 In addition to the consultation detailed below, the design at this site has been developed in light of ongoing consultation, which has been undertaken throughout the pre-submission phase, with consultees including English Heritage and the London Borough of Lambeth. Consultation has highlighted specific historic environment design considerations and helped to guide the direction of design development.

7.3.3 It was recognised that a key consideration was the need to resolve the relationship of the foreshore structures with the listed Vauxhall Bridge and the foreshore itself, while removing the historic Clapham and Brixton CSOs either side of the bridge. Another consideration was to preserve the setting of the Albert Embankment to the north. The separation of the CSO interception structure from the CSO drop shaft structure was seen as a way of reducing the impacts. The siting of the CSO drop shaft on a recessed stretch of river wall to the north of Lacks Dock, so that it would not project forward from the river wall of the listed embankment and the river wall in front of Vauxhall Cross, was also designed to protect the settings of the listed bridge and the listed Albert Embankment.

7.3.4 The solution to the design of the interception structure around the bridge, which is supported by both English Heritage and LB Lambeth, was to design the proposed low, floodable foreshore structures, thus maintaining the current line of the embankment around the bridge and ensuring the primacy and visibility of its western abutment. The proposed structure has also been designed with no intrusive connection to the listed fabric to ensure reversibility.

Vol 16 Table 7.3.1 Historic environment – stakeholder engagement summary

Organisation and date	Comment	Response
English Heritage Public consultation phase one (January 2011)	The site presents the risk of loss of a recently discovered archaeological site [Mesolithic artefacts, possibly man-made timbers] of demonstrably equivalent significance to a scheduled monument. Extensive archaeological mitigation is likely to be necessary.	An assessment of effects on this asset is presented in this section and mitigation measures are detailed in Section 7.8.

Organisation and date	Comment	Response
London Borough of Lambeth Scoping opinion (April 2011)	Need for permanent improvements to quality of site to enhance public experience and use of the riverside.	Design measures to enhance the visitor experience are included within the *Design Principles* report.
	An assessment methodology for setting should be agreed with English Heritage.	The methodology for the assessment of effects on setting has been agreed with English Heritage.
	Mitigation will need to be determined after a fuller assessment of the environmental impacts.	The *Environmental Statement* provides a detailed assessment of likely significant effects and proposes measures to mitigate adverse effects.
Heritage design workshop (December 2011)	English Heritage noted that interpretation was important in relation to the possible Mesolithic timber structure at this site.	Design measures to enhance the visitor experience, including through interpretation of the historic environment, are included with the *Design Principles* report.
Meeting with LB Lambeth and English Heritage (1st December 2012)	LB Lambeth confirmed that they were happy with the general design principles and would be looking at materials, they noted some reservations about the proposed interpretation and use of timber in balustrades	The feedback was welcomed and design has been refined further.
Record summary of meeting with English Heritage (1st February 2012)	English Heritage expressed the view that the design was very successful.	This feedback was welcomed.
English Heritage Phase two consultation response	Vauxhall Bridge not identified as a receptor for vibration.	An assessment of effects from noise and vibration is included in Section 9. Vauxhall Bridge is not identified

Organisation and date	Comment	Response
(February 2012)		as a receptor as it falls outside the scope of the assessment (see the methodology detailed in Volume 2 – Section 9).
	English Heritage requests that a geotechnical report that is being prepared be submitted to GLAAS for comment.	The results of the geotechnical investigation have been incorporated into the environmental baseline (Section 7.4) of the *Environmental Statement*.
	Prehistoric feature on foreshore of national importance. Request for a detailed foreshore topographical survey; plotting of the Mesolithic wood with detailed plans; partial removal to check for human intervention; analysis of peat and other deposits; and regular foreshore survey.	The *Environmental Statement* details measures to mitigate likely significant effects on this asset, which would include the elements requested by English Heritage. The scope of any field investigation would be agreed with the statutory consultees prior to commencement. Mitigation is detailed in Section 7.8.
	The archaeological implications of dredging need to be taken into account.	Dredging is not proposed at this site.
	In respect of the proposed cofferdams and access road, English Heritage requests that these are designed to minimise the impact upon the Mesolithic feature, and where this is not feasible that it is archaeologically excavated.	An assessment of effects on this asset is presented in this assessment and mitigation measures are detailed in Section 7.8.

Organisation and date	Comment	Response
	Request for periodic foreshore monitoring during the operational phase with limited archaeological excavation where necessary.	Foreshore protection measures are incorporated into the proposed operational development to avoid the occurrence of scour during the operational phase.
English Heritage Mitigation meeting (April 2012)	Mesolithic remains are being increasingly exposed due to new Thames Clipper service and pier at Vauxhall. Information about these resources should be recorded before they are lost.	Measures to mitigate likely significant effects are detailed in Section 7.8. These include foreshore condition monitoring and targeted excavation.
English Heritage Section 48 publicity comments	English Heritage considers that the mitigation strategy at Albert Embankment Foreshore may need expanding following further investigation.	Mitigation measures are detailed in Section 7.8. These would be refined in line with the process detailed in the *Overarching Archaeological Written Scheme of Investigation* (Vol 2 Appendix E.2).

Baseline

7.3.5 The baseline methodology follows the methodology described in Vol 2. It should be noted that whilst most topics within the assessment use the term 'value' to define the sensitivity of environmental receptors within the baseline, the historic environment assessment uses 'asset significance' as per the terminology used within the NPS. Distinction is made between the significance of the resource, i.e. asset significance, and the significance of the environmental effect throughout the following assessment.

7.3.6 Baseline conditions for above-ground and buried assets are described within a 250m-radius area around the centre point of the site which is considered through professional judgement to be most appropriate to characterise the historic environment potential of the site. There are occasional references to assets beyond the baseline area, for example, a small medieval settlement approximately 770m to the south of the site, which contributes to current understanding of the site and its environs in the later medieval period.

7.3.7 The assessment area for effects on the historic character and setting of above-ground heritage assets has been defined using professional judgement by identifying heritage assets within the Zone of Theoretical Visibility (ZTV), generated as part of the townscape and visual assessment (see Section 11), whose settings have the potential to be significantly affected by the proposed scheme. The setting of these assets is then described in the baseline. Where appropriate this assessment area extends beyond the 250m radius baseline area. In addition, 'Views of Heritage Value' (VHV) considered important for understanding the historic character and setting of heritage assets have been identified where appropriate. These are drawn from the conservation area appraisals, audits or statements for Albert Embankment and Millbank conservation areas and from professional judgement based on observation and understanding of historic context and architectural purpose and design.

7.3.8 A site visit was carried out in April 2011 to identify heritage assets on or adjacent to the site. Site visits were also carried out in March 2011 and January 2012 to identify assets for inclusion within the assessment of effects on setting.

Construction

7.3.9 The assessment methodology for the construction phase follows that described in Vol 2. There are no site-specific variations for undertaking the construction assessment of this site.

7.3.10 In terms of physical effects on above-ground or buried assets, likely significant effects could arise throughout the construction phase. Effects arising from all stages of the construction period are therefore assessed. The construction assessment area for such effects is defined by the site boundary.

7.3.11 In terms of effects on the character and setting of above-ground heritage assets, while there would be effects throughout the construction period the peak construction phase is Site Year 2, when the shaft would be under construction and cranes would be present at the site. This has been used as the assessment year for effects on the character and setting of heritage assets. It should be noted that in some instances, the townscape and visual assessments may differ to the historic environment assessments despite the receptors being largely coincident. This is due to the different value / sensitivity that may be attributed to a receptor and also due to consideration of different factors when assessing the magnitude of change and significance of effect (the reasoning is explained for each receptor as appropriate). The construction assessment area is as described in para 7.3.7.

7.3.12 Section 7.5 details the likely significant effects arising from the construction at the Albert Embankment Foreshore site. There are no other Thames Tideway Tunnel project sites which could give rise to additional effects on the historic environment within the assessment area for this site as the nearest sites (Heathwall Pumping Station to the west and Victoria Embankment Foreshore to the east) are too distant from Albert

Embankment Foreshore site to have significant effects on the setting of the relevant heritage assets. Therefore no other Thames Tideway Tunnel project sites are considered in this assessment.

7.3.13 None of the schemes included in the site development schedule (Vol 16 Appendix N) would lead to physical changes in above-ground or buried heritage assets within the Albert Embankment Foreshore site. Furthermore, archaeological remains are a static resource, which have reached equilibrium with their environment and do not change (ie decay or grow) unless their environment changes as a result of human or natural intervention. At this site ongoing fluvial erosion is changing the archaeological baseline within the foreshore. However, the rate of erosion is not known so the base case is assumed to be as per the baseline.

7.3.14 Whilst the baseline within the area beyond the site may change as a result of any archaeological excavation and recording carried out as part of a standard program of mitigation for other developments, such information is unlikely to significantly change the current understanding of the historic environment of the site. Therefore any changes to the surrounding baseline would not affect the assessment and are not detailed further within the construction base case.

7.3.15 None of the schemes included in the site development schedule (Vol 16 Appendix N) would change the existing baseline in terms of character and setting of above-ground assets given the distance of these schemes from the site and the presence of intervening structures. Therefore the construction base case remains as per the baseline detailed in Section 7.4.

7.3.16 None of the schemes included in the site development schedule (Vol 16 Appendix N) would have a significant physical cumulative effect on buried or above-ground heritage assets within the site. This is because there are no assets common to Albert Embankment Foreshore site and those schemes listed in the development schedule. Therefore no assessment of cumulative effects has been undertaken for physical effects on assets in the construction phase.

7.3.17 Similarly none of the schemes included in the site development schedule (Vol 16 Appendix N) would have a significant cumulative effect on the historic character and setting of above-ground heritage assets because of the distance of these schemes from the site and the presence of intervening structures. Therefore no assessment of cumulative effects has been undertaken for effects on the historic character and setting of above-ground heritage assets in the construction phase.

7.3.18 The assessment of construction effects on the character, appearance and setting of heritage assets also considers the extent to which the assessment findings would be likely to be materially different, should the programme for the Thames Tideway Tunnel project be delayed by approximately one year, for example due to changes in schemes which form part of the base case or cumulative assessment. In the case of buried heritage, as described above, whilst the baseline within the baseline area beyond the site may change as a result of any archaeological excavation and recording carried out as part of a standard programme of mitigation for other developments, such information is unlikely to significantly change the current understanding of the historic environment of the site. Therefore a delay to the Thames Tideway Tunnel project, with a consequent change in other schemes which may have been developed by the time of Thames Tideway Tunnel construction, would not lead to any change in the archaeological baseline and therefore no change in the assessment of effects on these assets.

Operation

7.3.19 The assessment methodology for the operational phase follows that described in Vol 2. There are no site-specific variations for undertaking the operational assessment of this site which is based on an assessment in Year 1 of operation, when the proposed development's full effect upon its surroundings would be evident. As with the construction assessment, it should be noted that in some instances the townscape and visual assessments may differ to the historic environment assessments of the operational phase, despite the receptors being largely coincident. This is due to the different value / sensitivity that may be attributed to a receptor and also due to consideration of different factors when assessing the magnitude of change and significance of effect (the reasoning is explained for each receptor as appropriate). The operational assessment area is as described in para. 7.3.7.

7.3.20 As stated in para. 7.3.15 there are no other Thames Tideway Tunnel project sites which could give rise to additional effects on the assessment of the historic environment at this site. Therefore no other Thames Tideway Tunnel project sites are considered.

7.3.21 None of the schemes included in the site development schedule (Vol 16 Appendix N) would change the existing baseline in terms of the character and setting of above-ground heritage assets given the distance of these schemes from the site and the presence of intervening structures. Therefore the operational base case remains as per the baseline detailed in Section 7.4.

7.3.22 Similarly none of the schemes included in the site development schedule (Vol 16 Appendix N) would have a significant cumulative effect on the historic character and setting of above-ground heritage assets because of the distance of these schemes from the site and the presence of intervening structures.

7.3.23 The assessment of operational effects on the character, appearance and setting of heritage assets also considers the extent to which the assessment findings would be likely to be materially different, should the programme for the Thames Tideway Tunnel project be delayed by approximately one year, for example due to changes in schemes which form part of the base case or cumulative assessment.

Assumptions and limitations

7.3.24 The assumptions and limitations associated with this assessment are presented in Vol 2. Site-specific assumptions and limitations are detailed below.

Assumptions

7.3.25 The assessment of effects on buried heritage assets is based on the shaft and other below-ground structures being located anywhere within the zones identified on the permanent works plan for these structures. For this site the assessment is not sensitive to variations in location within these zones because although it is recognised that there is a known buried heritage asset of high significance this would have been archaeologically excavated and recorded after insertion of the temporary cofferdam (see Site works parameter plan, separate volume of figures - Section 1).

7.3.26 A number of assumptions have been made regarding the likely depth of temporary construction works (eg site strip, footings for plant and accommodation), based on professional knowledge of construction projects. Whilst the precise nature of construction effects on buried heritage would vary if the depths varied, the mitigation proposed to address any effects would remain as stated, as would the residual effects. These assumptions are detailed in Section 7.2.

7.3.27 Vol 2 details assumptions made regarding the predicted impact of compression of potential archaeological assets within the foreshore from temporary cofferdam fill material. For the purposes of this assessment it has been assumed that where archaeological remains within the foreshore could contain voids, and/or are made of porous/organic material (timber structures/objects such as wattle, fishtraps, and peat), the compression predicted to occur is likely to cause some damage. Where such remains could be solid, non-porous or inorganic without voids, such as metal, stone, flint or brick, the compression is generally unlikely to lead to damage.

7.3.28 The assessment of effects on the historic character and setting of above-ground heritage assets is similarly based on the proposed above-ground structures being located anywhere within the zones for these structures. For this site the assessment is not sensitive to variations in location within these zones because of the open character of the surrounding townscape.

Limitations

7.3.29 A limitation of the assessment is that only non-intrusive archaeological investigation has been carried out on the site in the past and few investigations have been carried out in the baseline area around the site. Nevertheless the assessment is considered to be robust and in accordance with best practice.

7.3.30 There has also been little research into the effects of compression of buried heritage assets within foreshore alluvium from fill material placed on top of such deposits. Professional judgement has been used to estimate the likely impacts on different archaeological remains within the foreshore, and the assessment is considered to be robust.

7.4 Baseline conditions

7.4.1 The following section sets out the baseline conditions for the historic environment within and around the site. Future baseline conditions (base case), which would remain as per the baseline, are also described. The section comprises seven sub-sections:

a. a description of historic environment features within the 250m-radius baseline area

b. a description of statutorily designated assets within the site and baseline area. Locally designated assets and known burial grounds are included, where relevant, as described in Volume 2

c. a description of the site location, topography and geology

d. a summary of past archaeological investigation, providing an indication of how well the area is understood archaeologically

e. a chronological summary of the archaeological and historical background of the site and its environs

f. a statement of significance for buried heritage assets, taking account of factors affecting survival

g. a statement of significance for above-ground assets within and around the site, describing the features which contribute to their significance, including historic character, appearance and setting.

Current baseline

Historic environment features

7.4.2 The historic environment features map (see Vol 16 Figure 7.4.1 in separate volume of figures) shows the location of known above-ground and buried historic environment features within the 250m-radius baseline area, compiled from the baseline sources set out in the methodology in Vol 2. These have been allocated a unique historic environment assessment reference number (HEA 1, 2, etc), which are listed in the gazetteer in Vol 16 Appendix E.1. Heritage assets whose historic character and / or settings would be affected by the proposed development are shown on Vol 16 Figure 7.4.2 (see separate volume of figures) along with Views of Heritage Value (VHV), as described in Section 7.5. It should be noted that the baseline for the assessment of effects on the character, appearance and setting of heritage assets, is informed by professional judgement and the ZTV, with assets described further in a 'Statement of significance: above-ground heritage assets' below at paras 7.4.35 - 7.4.47.

Designated assets

International and national designations

7.4.3 Vauxhall Bridge, which is Grade II* listed (HEA 1n), is located in the southern part of the site. There is a group of four Grade II listed benches (HEA 13) on the Embankment Footpath, c 110m north of the site, along the path adjacent to the Grade II listed embankment wall and lamp standards (HEA 15), as far as Alembic House. The Palace of Westminster World Heritage Site is located around 1km north of the site.

Local authority designations

7.4.4 The eastern part of the site lies within the North Lambeth and Lambeth Palace archaeological priority area. The site lies within the Albert Embankment Conservation Area. The site is opposite Millbank Conservation Area. There are no locally listed buildings nearby.

Known burial grounds

7.4.5 There are no known burial grounds within the site or adjacent to it.

Site location, topography and geology

7.4.6 The site lies on the eastern bank of the River Thames. The former River Effra, a tributary of the Thames, ran into the eastern side of the Thames in the vicinity of Vauxhall and the site. The foreshore within the site slopes upwards from west to east and from south to north. Within the site the foreshore at low water level is at 98.4m ATD in the southwest (above Tunnel Datum, the equivalent of –1.6m Ordnance Datum) rising to 99.9m ATD to the northeast. The foreshore adjacent to the river wall is 99.9m ATD in the southwest rising to 101.4m to the northeast. Along the top of the embankment within the site the ground level lies between 105.0–106.3m ATD. The foreshore has until recently been relatively stable; it has, however, become an extremely dynamic environment since the construction of a new pier upstream.

7.4.7 Geologically, the site is situated in an area of alluvial silts overlying sand and gravel deposits associated with the floodplain of the River Thames. The Kempton Park gravel terrace is 25m to the east of the site (British Geological Survey, date)[1]. The site topography and geology is discussed in more detail in Vol 16 Appendix E.2 and their interpretation will be refined on receipt of data from boreholes planned to be carried out within the site.

Past archaeological investigations

7.4.8 Foreshore surveys recorded a roundwood possible piled structure in the western part of the site, which has been radiocarbon dated to the Late Mesolithic period, along with associated prehistoric peat deposits and at least one other horizon of this date (HEA 1a). A large amount of Mesolithic and Neolithic flint tools and burnt flint has been recorded eroding out of these deposits, along with Early Neolithic pottery and an antler pick. Several, probably post-medieval, timber structures were also noted in the southern part of the site (Vol 16 Appendix E.3), these are shown in Vol 16 Figure 7.4.3 (see separate volume of figures).

7.4.9 These surveys also recorded some degradation of the foreshore from its cutting away by the modern river (HEA 1G). A number of consolidation layers and dumps were recorded, ranging from modern concrete to undated deposits which may be archaeological (HEA 1B; 1E; 1H). These consolidation attempts indicate past erosion of the Thames on the foreshore at this point. A number of wooden artefacts of post-medieval date were recorded; these comprised timbers with metal feet (HEA 1D;

1F); the leeboard of a vessel (HEA 1C); and timber mooring blocks and drains (HEA 1F). Some of this material is likely to be redeposited wood, but the mooring blocks, drains and leeboard may be associated with historic use of the site.

7.4.10 Other archaeological investigations in the area (see gazetteer in Vol 16 Appendix A.1) have also provided information on the historic use of the area for pottery and glass manufacture (HEA 2; 3; 6). Further details of past archaeological investigations carried out within the site and baseline area are included in Vol 16 Appendix E.3.

Archaeological and historical background of the site

7.4.11 The following section presents a chronological summary of the archaeological and historical background of the site. Further detail is included in Vol 16 Appendix E.4.

7.4.12 The site would have been within an area which may have comprised marsh, dry land and river channel at different times throughout the prehistoric period (700,000 BC–AD 43). In such areas, prehistoric populations sometimes constructed wooden trackways to cross wet areas. These trackways may have sometimes been associated with ritual activity and votive deposits. Wood of Mesolithic date (radio-carbon dated to c 4,500BC) has been located within the site (HEA 1a). If it were found to be a structure, then this would be the oldest such feature in London. The piles were found close to a flint scatter, individual flint artefacts and Neolithic pottery and other finds. An *in situ* peat deposit, overlain by a further *in situ* prehistoric layer may be associated with the possible piles. A large number of struck flints dating to the Mesolithic and Early Neolithic period, including a tranchet adze (a flint carpentry tool), a quantity of sherds of early Neolithic pottery, two undated, possibly prehistoric, red deer bones and a large quantity of possibly prehistoric burnt flint have been recovered from these layers (HEA 38). The quantity of anthropogenic material eroding out of these layers suggests that the site was occupied during this period, rather than just being indicative of a population presence in the area.

7.4.13 Within the baseline area further prehistoric evidence includes a Neolithic or Bronze Age lithic implement (HEA 22), a prehistoric axe, a Neolithic axe and two Bronze Age bronze swords (HEA 8). A copper alloy tanged Bronze Age chisel (HEA 35) was also recovered from the Thames near the Albert Embankment, just upstream of Vauxhall Bridge, immediately to the south of the site. A further peat deposit containing Mesolithic and Neolithic flints and burnt flint has also recently been recorded. At St George’s Wharf, approximately 90m southeast of the site Bronze Age a timber feature was recorded (HEA 10) and further peat deposits containing Mesolithic, Neolithic and Bronze Age material. A Bronze Age flake was recorded approximately 90m northeast of the site (HEA 2). A short distance beyond the baseline area and close to its southwestern edge a timber piled structure, thought to be the foundations for a bridge or jetty, has been recorded, with two associated apparently ritually deposited metal spearheads; two of its piles have been radiocarbon–dated to the Bronze Age.

7.4.14 The recently exposed peat deposits by St George's Wharf, also close to the southern edge of the baseline area but just beyond it, were cut by a structure comprising four small roundwood stakes which have been radiocarbon-dated to the Late Bronze Age or early Iron Age and may have been may be a fish trap.

7.4.15 During the Roman period (AD 43–410) the site was not located close to any known roads, indicating that it is unlikely to have been a focus for settlement or burial activity. During the Roman period the Albert Embankment Foreshore site may have been prone to flooding and probably lay in open marshland or on the foreshore of the Roman Thames. Evidence of Roman activity in the area is limited to a late Roman pottery vessel found adjacent to the Albert Embankment Foreshore site (HEA 1h). The limited evidence of Roman activity and the fact that sea levels rose at this time suggest that the site would have been unsuitable for habitation.

7.4.16 During the early medieval period (AD 410–1066) the site was some distance from the nearest known settlements and would probably have been unsuitable for habitation due to rising water levels. No evidence of early medieval activity has been recorded within the site. Outside the site a gully of possible early medieval date, underlying a sandy soil containing later medieval pottery was recorded approximately 90m northeast of the site (HEA 2). Two medieval swords were found in the Thames, approximately 40m and 70m west of the site (HEA 8 and 9). It is possible that the site was located near to an early ferry, perhaps a predecessor to the Horse Ferry which was replaced by Vauxhall Bridge.

7.4.17 There is no evidence of medieval activity within the site, but in the baseline area some later medieval features and buildings have been recorded including stone foundations of a possible later medieval building (HEA 2) and a wharf (HEA 17). In the later medieval period (AD 1066–1485) much of the area remained as low-lying marshland and open fields crossed by a few roads raised against floods and is unlikely to have been suitable for habitation. The site is located in Vauxhall, a place name first mentioned in documentary sources in 1262. There may have been a medieval settlement at the eastern side of modern Vauxhall Bridge to the east of the site, and a small settlement approximately 770m to the south of the site. At the junction of Wandsworth Road and South Lambeth Road, where a railway bridge now stands, was Cox's Bridge (in existence by 1340, and sometimes called Vauxhall Bridge) over the northern channel of the Effra.

7.4.18 During the early post-medieval period (AD 1485–present) the riverside area comprised marshy fields and much of the site remained within the Thames river channel or foreshore during this period. In the baseline area there was a substantial waterfront complex from the 17th-century. Outside the site, approximately 60m to the east (HEA 3), an undated burial was recorded, probably of post-medieval date. During the 17th and 18th centuries the character of the baseline area was industrial. Evidence recorded within the baseline area includes a post-medieval armoury (HEA 11), a 17th-century stone-working site (HEA 34). A post-medieval glasshouse (glassworks) was constructed 1615, which operated until

1786, and gave its name to Glasshouse Street to the east of the site (HEA 18). A Soap Boiler's, distillery and pub were founded in the 18th and early 19th century. Vauxhall was also the location of an important pottery, with pottery manufacturing extending eastwards from the site over an extensive area (HEA 2, 6, 7, 21 and 28).

7.4.19 Map evidence shows the site located within the River Thames in the 17th-18th centuries. In the latter part of this period the eastern edge of the site was reclaimed from the river and included some buildings, probably warehouses, constructed along the river front, several small docks or wharves and some small plots of land The site extends west along the southern side of a former road that led to Vauxhall Stairs and included a row of buildings fronting onto that road.

7.4.20 In the early 19th century a new bridge was constructed on the southern part of the site, necessitating the demolition of several buildings (HEA 27 and 36). This bridge replaced a former Horse Ferry. In 1906, the original Vauxhall Bridge was replaced by the current Grade II* listed structure (HEA 15). The site predominantly remained a mix of foreshore land and industrial uses throughout the 19th century. Buildings in the southeastern and central portions of the site suffered some blast damage during the Second World War. Modern development has also taken place including the construction of Camelford House and the Vauxhall Cross.

7.4.21 The site currently comprises an area of Thames foreshore with associated alluvial mud, aggradation and consolidation deposits. Vauxhall Bridge (HEA 15) is flanked to the north and south by two sewer outfalls with associated timber dolphins and granite cobbled slipways. A brick and stone river wall (HEA 39) is located along the eastern side of the site. To the southeast, the site includes part of the embankment associated with Bridge House.

Statement of significance: buried heritage assets on the site

Introduction

7.4.22 The following section discusses past impacts on the site which are likely to have compromised asset survival (generally from late 19th and 20th century developments, for example, building foundations), identified from historic maps, the site walkover survey, and information on the likely depth of deposits.

7.4.23 In accordance with the *National Policy Statement for Waste Water* (Defra, 2012)[2], *National Planning Policy Framework* (DCLG, 2012)[3] and *PPS5 Planning Practice Guide* (DCLG, 2012)[4] (which remains extant) and national planning policy guidance, this is followed by a statement on the likely potential for and significance of buried heritage assets within the site, derived from current understanding of the baseline conditions, past impacts, and professional judgement.

Factors affecting survival

7.4.24 Archaeological survival potential across the site is generally likely to be moderate to high within the foreshore area, with a known possible structure of Mesolithic date and intact prehistoric land surfaces having been recently recorded.

7.4.25 Within the embankments and the former Lack's Dock, archaeological survival potential may have been lessened with disturbance from past foundations and dock construction. Other factors affecting survival include:

a. Localised removal of archaeological remains within the foundations for the present and previous Vauxhall Bridges, the slipway at Lack's Dock, dolphins and sewage outflows. Any other constructions, such as modern mooring posts, would also have locally removed archaeological remains. The foreshore in front of the Vauxhall Cross has been scoured by ongoing fluvial action and an unknown depth of alluvium and archaeological remains may have been removed.

b. Ongoing erosion of the foreshore deposits as observed by the TDP during early 2012, possibly exacerbated by the construction and operation of the new river pier upstream of the baseline area.

c. It is likely that the construction of the warehouses along the eastern boundary of the site from the 19th-century onwards would have locally removed archaeological remains within the footprint of their foundations and services to a depth of approximately 1.0–1.5mbgl (possibly deeper for pad foundations of the larger buildings) and up to 3mbgl for basements/cellars. This would have truncated locally any remains at the top of the alluvium and within the overlying made ground (eg any later medieval and post-medieval remains), although deeper (and earlier) assets may survive intact below.

7.4.26 Behind the river wall the archaeological deposit sequence may be much deeper, including made ground, alluvium and gravels, depending on the past action of the river in this area. The combined effect of 19th/20th century building development is likely to have significantly reduced the upper levels of archaeological deposits and hence asset significance, although localised remains at deeper (earlier) levels could be present.

Asset potential and significance

7.4.27 The following statement of asset significance takes into account the levels of natural geology and the level and nature of later disturbance and truncation.

Palaeoenvironmental

7.4.28 The site has a moderate potential to contain palaeoenvironmental remains. Prehistoric peat was recorded on the site (HEA 1a), but the exposure of Mesolithic remains and evidence from boreholes suggested that the depth of any clay, peat or wood deposits is likely to be localised due to the scouring of the river. If they are present, any deposits of peaty clay and clay and wood have a high potential to preserve palaeoenvironmental evidence (pollen, plant macro fossils), which if present can be utilised to reconstruct the past palaeoecology of the floodplain and environments within which prehistoric occupation occurred. Any fluvial and estuarine deposits also have the potential to preserve palaeoenvironmental remains (ostracods, foraminifera, diatoms) which can be utilised to reconstruct the past fluvial regimes and indicate the onset of tidal inundations and the transition to an estuarine river environment. Given the presence of a possible in situ prehistoric structure and prehistoric artefacts (see below), the paleoenvironmental significance of the deposits on the foreshore is considered to be high.

Prehistoric

7.4.29 The site has a high potential to contain prehistoric remains. A possible Mesolithic structure, *in situ* prehistoric land horizons and large quantities of associated artefacts have been recorded across the site, although scouring of the river is having an impact on these remains. Other *in situ* prehistoric horizons and associated artefacts have been found within the baseline area. *In situ* remains, such as those recorded on the site, would be of high significance, derived from their evidential value, but are at risk of degradation from the scouring of the river.

Setting of possible Mesolithic structure

7.4.30 The setting of the possible Mesolithic structure (HEA 1a), an asset of high significance, currently exposed on the foreshore of the Thames contributes to its significance in having the potential to supply evidence of local topography and land use in prehistoric times, including from palaeoenvironmental sampling. Throughout the long Mesolithic period, evidence of activity in the London area appears to have been far more common close to river banks and valleys than elsewhere. The position of this site at the confluence of the Thames and its tributary, the Effra, is similar to that of the confluence of the Thames and the Wandle around which several Mesolithic sites and findspots are known. The course of the River Thames has changed through time, so that many often fragile Mesolithic sites which might previously have been close to a river bank may have been lost within the development of Greater London. This site, on the undeveloped foreshore of the Thames, is a very rare survival of a later Mesolithic structure, a period which is under-represented in the archaeological record other than through flint artefacts. The significance of its setting is further enhanced by its proximity and apparent association with other prehistoric settlement sites along this stretch of the foreshore, including the findspots of Neolithic pottery within the site, a Bronze Age piled structure (a bridge or jetty foundation with associated metal objects, probably ritually deposited) just beyond the baseline area to the south, and an Iron Age fish trap in the same area. Remains of the Mesolithic timbers may be seen from the Thames Path and Vauxhall Bridge at low tides.

Roman

7.4.31 The site has a low potential to contain Roman remains. It was located some distance from known roads and potential settlements in an area of probably marshy open land close to the Thames. Roman finds from within the baseline area have been limited and the exposure of Mesolithic remains suggests that any Roman remains present may have previously been removed by the river. Isolated artefacts would be of low significance.

Early medieval

7.4.32 The site has a low potential to contain early medieval remains. The site was located some distance from known settlements. Although several assets of this period have been recorded within the baseline area, the scouring of the river may have removed most early medieval remains. Isolated artefacts would be of low significance, if present.

Later medieval

7.4.33 The site has a low potential to contain later medieval remains, primarily remains associated with river use and a possible ferry. A ferry operated close to the site prior to the construction of the Vauxhall Bridge. A wharf associated with the construction of Westminster Abbey is also known to have been present nearby, although such remains are usually to be found on the landward sides of the modern river walls. Although the site was some distance from nearby settlements and unsuitable for habitation, remains associated with waterfront activity may be present on the site. Evidence associated with the ferry or other river usage (eg mooring posts) would be of low significance, derived from their potential evidential and historical value.

Post-medieval

7.4.34 The site has a high potential to contain post-medieval remains. The area east of the site was developed extensively during this period, primarily by industrial properties, including the Vauxhall Glasshouse and Pottery. Archaeological remains associated with these industries have been found within the baseline area. Features associated with such industries may be present on the site, including wharfage, dumps of waste materials, jetties and anchor points. Such remains, if present, would be of low significance. This would be derived from the evidential and historical value of such remains.

Statement of significance: above-ground heritage assets

Introduction

7.4.35 In accordance with the *National Planning Policy Framework* and the associated guidance, the following section provides a statement of the likely significance of heritage assets based on professional and expert judgement. The significance of assets is a reflection of their value or importance, derived from their perceived historical, evidential, aesthetic and communal value. These terms are defined in Vol 2.

7.4.36 It also describes the significance, historic character and setting of conservation areas and settings of listed buildings within the construction and operational Zones of Theoretical Visibility (ZTV) where their historic character, appearance and settings may be affected by the proposed development. Such assets are shown in Vol 16 Figure 7.4.2 (see separate volume of figures). This figure also shows the construction and operational ZTVs and Views of Heritage Value (VHV) which illustrate important views to and from heritage assets. There are no other heritage assets in the assessment area whose settings would be significantly adversely affected by the proposed development.

Within the site

Albert Embankment Conservation Area

7.4.37 The site lies within the Albert Embankment Conservation Area (see Vol 16 Figure 7.4.2 in separate volume of figures), as designated by the LB of Lambeth. Its character "is clearly defined by its location along the River Thames and the borough boundaries to the west (with Westminster) and south (with Wandsworth). Over half of the area of the conservation area is occupied by the River Thames itself, including the shingle foreshore and mud-banks, the Fire Brigade Pier and Vauxhall Bridge rebuilt in 1906"(LB of Lambeth, 2001)[5]. The area also includes the Vauxhall Cross (see para. 7.4.46 below). Only four industrial buildings from the 18th and 19th century survive within the conservation Area: the former Royal Doulton Building (now Southbank House), the Crown Public House (now the Rivers Bar), the Windmill Public House and 37-37 Albert Embankment which is a four storey warehouse. The rest of the conservation area extends north to Lambeth Bridge along the line of the Grade II Listed 1869 Bazalgette Embankment Wall. It excludes the modern office blocks and creek inlet adjacent to the Vauxhall Cross.

7.4.38 With the exception of the Embankment Wall and Albert Embankment Gardens, the river frontage of the Albert Embankment Conservation Area is largely characterised by modern developments (see Vol 16 Plate 7.4.1). These include Camelford House, Tintagel House and Peninsular Heights just north of Lack's Dock, which front onto the river, and the other modern buildings further north which are set back behind the road. These buildings are not included within the conservation area boundary as they "are considered to be of little architectural or townscape merit"[6] but they do form part of its setting, as framing elements in views along the River Thames

7.4.39 There are far reaching views across the river northwards towards the Millbank Conservation Area, largely focused on the Grade I Listed Tate Britain, and beyond towards the Palace of Westminster World Heritage Site. There are also views southwards along the line of the river front and towards Vauxhall Bridge from Lambeth Bridge (see View of Heritage Value 2, Vol 16 Figure 7.4.2 in separate volume of figures and Vol 16 Plate 7.4.2). The Grade II* Vauxhall Bridge forms a significant element within the Albert Embankment Conservation Area. The setting of the Albert Embankment Conservation Area to the south of Vauxhall Bridge is characterised by modern residential development and distant views along the river frontage towards Battersea Power Station. The Millbank Conservation Area on the north side of the river contributes to the setting of the Albert Embankment Conservation.

7.4.40 The Albert Embankment Conservation Area was designated to recognise and protect the historic significance of Albert Embankment and the engineering achievement it represents as part of Bazalgette's grand scheme (including the signature dolphin/sturgeon lamps and benches on his Albert Embankment) and the surviving small docks associated with it. Conservation area status also recognises the architectural significance of the two major landmark buildings on the Embankment: the monumental post-modern Vauxhall Cross at Vauxhall Bridge and the art deco London Fire Brigade Headquarters, along with what survives of the 19th century heritage of the area. However, with the exception of Vauxhall Bridge, the historic character and appearance of the southern part of the Albert Embankment Conservation Area is limited. Nonetheless, the conservation area is considered to be a heritage asset of high significance.

Vol 16 Plate 7.4.1 Historic environment – view from embankment wall at the fore of the Vauxhall Cross eastwards along Albert Embankment towards Lambeth Bridge

Vol 16 Plate 7.4.2 Historic environment – view from Albert Embankment adjacent to Lambeth Bridge west towards Vauxhall Bridge

Vauxhall Bridge

7.4.41 Vauxhall Bridge (HEA 1n) is a Grade II* listed structure. It was designed by two chief engineers of the London County Council. Construction difficulties, including the inability of the river clays to support the originally intended concrete structure resulted in changes in the design, to the steel superstructure visible today. A significant aspect of the bridge is its sculptures by Alfred Drury RA and Fredrick Pomeroy RA, of female figures representing functions of local government (further detailed in Vol 16 Appendix E.4). The bridge is a heritage asset of high significance, and is considered to have group value with Lambeth Bridge, which was constructed in 1929.

7.4.42 The setting of Vauxhall Bridge is defined by the composition created by the Albert Embankment, the River Thames and the embankment on the eastern side of the River Thames. At its eastern end, where it crosses the Albert Embankment Foreshore Thames Tideway Tunnel project site, its setting is characterised by the modern embankment wall to the fore of the Vauxhall Cross which abuts the bridge (see Vol 16 Plate 7.4.3). There are Views of Heritage Value along the length of the bridge (VHV 5 & 6, see Vol 16 Figure 7.4.2 in separate volume of figures) and from the bridge to the north towards Lambeth Bridge (VHV 4, see Vol 16 Figure 7.4.2 in separate volume of figures) and south towards Battersea Power Station (VHV 3, see Vol 16 Figure 7.4.2 in separate volume of figures). The Albert Embankment at this point is characterised by modern development and is devoid of historic character and therefore the contribution that it makes to the significance of the bridge is low.

Vol 16 Plate 7.4.3 Historic environment – view west from Albert Embankment towards southern abutment of Vauxhall Bridge

River wall

7.4.43 The river wall within the site (HEA 1m) is of historic interest, although it is not listed. Bazalgette's wall to the north of the site boundary is, however, listed and is of high significance. The wall within the site shows different phases of construction in both brick and stone, which probably relate to the former function of the river wall as a loading dock, with coal being unloaded from the river in this area (HEA 29). Parts of the masonry are likely to date to the 19th century, although there may be earlier elements below or beneath, whilst the upper brick courses are modern. Parts of this structure may pre-date Bazalgette's development. However there are also notable areas of relatively modern and unattractive character, leading the Conservation Area Designation Report to note it as "a shoddy concrete post-war retaining wall... in front of Tintagel House and Camelford House, to the former Lack's Dock".[7] The river wall therefore has evidential and historical value and is protected by its inclusion within the conservation area boundary. It represents a heritage asset of medium significance. Views south along the river wall include the eastern end of Vauxhall Bridge (see View of Heritage Value 1, Vol 16 Figure 7.4.2 in separate volume of figures).

Dolphin structures

7.4.44 On the foreshore, on either side of the southern abutment to Vauxhall Bridge, are two timber structures or dolphins (HEA 1f). Each structure contains the lower part of a storm relief outfall, and has a sewage flap valve on the end close to the low water mark to prevent river water ingress to the sewerage systems. The upper part of each storm relief outfall consists of another flap valve built into an opening in the existing river wall. The outfall on the north side of the bridge in front of Vauxhall Cross forms the entry point of the former River Effra into the Thames and is now known as the Brixton Storm Relief CSO. The outfall on the south side of the bridge in front of Bridge House is known as the Clapham Storm Relief CSO. The effluent from each outfall runs over heavy granite and concrete cobbled surfaces, or aprons, which survive albeit dislodged to some extent by the tides and/or discharges. Both outfalls were originally constructed in 1882 as part of the Effra Storm Relief scheme. The Brixton Storm Relief CSO was diverted and extended around the abutment to the present Vauxhall Bridge when it was constructed in 1906 and forms part of the scheme for the bridge and the foreshore. The Clapham Storm Relief CSO was not altered at that time although additional timber piles were constructed around it in 1934. As both outfalls are associated with the Grade II* listed bridge they are considered to be heritage assets of medium significance.

Lack's dock

7.4.45 Lack's Dock retains the outline of a 19th century dock and the 18th century Vauxhall Stairs (HEA 1l) and represents a heritage asset of medium significance for its evidential and historical value. The modern Lack's Dock retains the shape and outline of the historical dock with the historically significant inlet of Vauxhall Stairs dating back to the 18th century and the name to the 19th century. The aspect which makes it significant is that it is there as a historically continuous access route through the embankment wall on to the river, rather than the materials of the surrounding walls. Its visible defining walls and slipway, however, are made up of modern materials and are of negligible architectural interest.

Within the assessment area

Vauxhall Cross

7.4.46 Vauxhall Cross (HEA 40) was built in 1995 by Terry Farrell and Partners. The river wall in this area was extended out onto the foreshore as part of the design. The lamps along the river wall (Vol 16 Appendix A.5 Plate E.10) mirror the Art Deco revival style of the building. Several lion heads, with holding rings in their mouths on the river wall, facing out onto the Thames; these are likely to be recent replicas of the Bazalgette motif found elsewhere on the river, such as along the Victoria Embankment. Vauxhall Cross and the publicly accessible open area overlooking the foreshore are not listed; however they are included within the Albert Embankment Conservation Area. The building and associated features is considered a monumental landmark and a heritage asset of low significance. The setting of the building - including the river frontage structures, Lack's Dock and Vauxhall Bridge – makes a limited contribution to the significance of the Vauxhall Cross.

Millbank Conservation Area

7.4.47 The Millbank Conservation Area (see Vol 16 Plate 7.4.4) is considered a heritage asset of high significance as it preserves the layout of the former Millbank Penitentiary and contains a number of significant buildings, notably the Grade I Listed Tate Britain, the Grade II* Listed Royal Army Medical College, Grade II* Queen Alexandra Military Hospital, and the Grade II Listed Officers Mess and Commandants House in the Royal Army Medical Corps, 46-57 Millbank and the Morpeth Arms Public House. The river frontage itself is defined by the strong, distinctive line of the Grade II Listed Embankment Wall and its characteristic sturgeon lanterns, which is separated from the buildings by the presence of a major road. The openness of the River Thames corridor contrasts with the built-up nature of the Millbank Conservation Area, with views across the river to the Albert Embankment and Vauxhall Bridge (see View of Heritage Value 7, Vol 16 Figure 7.4.2 in separate volume of figures). However, these views are restricted, particularly in summer, by the presence of mature London plane trees that line both sides of Millbank. Whilst Vauxhall Bridge is a distinctive element of the setting of the Millbank Conservation Area, the predominance of modern office blocks and residential buildings along the opposite bank of the river adjacent to the site means the Albert Embankment Conservation Area, which includes the Thames Tideway Tunnel project site, makes only a limited contribution to the setting of the Millbank Conservation Area (see Vol 16 Plate 7.4.4 below).

Vol 16 Plate 7.4.4 Historic environment – view southeast from steps of Tate Britain across Millbank towards Albert Embankment Conservation Area

Construction base case

7.4.48 As detailed in paras. 7.3.13 and 7.3.14 whilst ongoing fluvial erosion is changing the archaeological baseline within the foreshore, since the rate of erosion is not known the base case is assumed to be as per the baseline for the purposes of the assessment. Similarly as detailed in para.

7.3.12 and 7.3.15 no other non-Thames Tideway Tunnel project developments would change the base case.

Operational base case

7.4.49 For the reasons outlined in para. 7.3.19 the base case in Year 1 of operation would remain as per the baseline for the assessment of effects on historic character, appearance and setting.

7.5 Construction effects assessment

7.5.1 It is noted that there are two alternative construction access options to the northern cofferdam. The effects of both would be the same for buried and above ground heritage assets; therefore alternative assessments are not presented.

Buried heritage assets

7.5.2 Effects of construction works are described in the following section in the sequence in which they would occur, with the individual impacts from each phase described. The effects on heritage assets are summarised in Section 7.10, by chronological period.

Site setup

7.5.3 The establishment of the works compound would involve the erection of hoardings supported by posts and the diversion of existing services on the Thames Path along the eastern edge of the site, and the construction of welfare facilities. The depth of the new and diverted service trenches and the foundations for the welfare facilities would extend to a maximum depth of 1.5mbgl, as assumed for the purposes of this assessment. These would potentially locally truncate remains of post-medieval industrial buildings of low asset significance, partially reducing the asset significance to negligible within the affected area. Effects on earlier archaeological resources are not anticipated due to the shallow depth of these works. Given the localised nature these would comprise a low level of impact on these assets of low significance resulting in a **minor adverse** effect.

Construction of cofferdams, access ramp, campshed, scour protection, and CSO drop shaft and chambers

7.5.4 Multi-period archaeological remains are potentially located within the foreshore alluvium and possibly cut into the underlying gravels. These would be removed within the footprint of the proposed localised excavation of soft material (ie alluvium) down to the gravels, adjacent to the perimeter of the temporary cofferdam, access ramp, and river wall (see assumptions in para. 7.3.27) and within the entire permanent cofferdam footprint. This would constitute of high magnitude of impact on any buried heritage assets.

7.5.5 The movement of small plant machinery used to lay the geotextile layer across the cofferdam footprints prior to infilling, and used to remove the geotextile layer subsequently, would have an impact upon any archaeological remains on the surface of the foreshore and within the upper part of the alluvium, within the cofferdam footprints, through rutting and compaction, resulting in a localised high magnitude of impact.

7.5.6 The placement of temporary cofferdam fill material is predicted to have a high magnitude of impact due to compression of any remaining buried heritage assets within the foreshore alluvium and gravels which are not removed from within the cofferdam, where these are hollow (e.g. pottery vessels, hulked boats), and/or are made of porous/organic material (timber structures/objects such as wattle, fishtraps, and peat). Where remains are solid, non-porous or inorganic without voids, such as metal, stone, flint or brick, there is unlikely to be an impact.

7.5.7 A jack-up barge would be used to insert the sheet pile walls and would locally impact any buried heritage assets within the footprint of its supports. Within the area of the campshed, foreshore deposits would be removed to an approximate depth of 0.3m, as assumed for the purposes of this assessment. Excavation to a depth of 1.5m within the footprint of permanent scour protection would remove any surviving buried heritage assets within the foreshore alluvium to this depth. These works would have a high magnitude of impact.

7.5.8 Excavation of the CSO drop shaft and chambers would entirely remove any surviving archaeological remains within the footprint of each construction, which had not previously been removed by the aforementioned activities (see paras 7.5.4–7.5.6) during construction of the temporary cofferdam.

7.5.9 These activities would constitute a high magnitude of impact. The environmental effect would vary depending upon the heritage significance of the assets removed and compressed:

a. There is a high potential for prehistoric remains, including remains of a possible Mesolithic timber structure (the visible remains of which lie outside the footprint of the temporary cofferdam) and prehistoric land surfaces, along with associated palaeoenvironmental remains within possible palaeochannels of the Thames and the River Effra. These remains are of high asset significance. The removal of such remains would constitute a **major adverse** effect.

b. The setting of the possible Mesolithic structure would be compromised by the proposed works, which would remove much of the surrounding context in terms of archaeological material along with the immediate topography and geology. The relationship of the structure with the River Thames and the River Effra would be unchanged. The proposals would have a **major adverse** effect on the setting of the asset.

c. There is a low potential for Roman remains, including isolated artefacts. Any such remains would be of low asset significance. Removal of such remains would constitute a **minor adverse** effect.

d. There is a low potential for isolated early medieval remains, which could be of low significance. The removal of such remains would constitute a **minor adverse** effect.

e. There is a low potential for later medieval remains, which could comprise remains of a ferry or possible waterfront structures of low asset significance if present. Removal of such remains would constitute a **minor adverse** effect.

f. There is a high potential for post-medieval remains, some of which were observed during the site visit. This potentially includes remains of wharves, jetties, consolidation dumps and anchor points and would be of low asset significance. Removal of such remains could constitute a **minor adverse** effect.

7.5.10 There would also be a permanent outfall apron extending beyond the footprint of the southern temporary cofferdam, however at this location it would be in the deeper channel of the Thames, below the level at which archaeological remains might be anticipated, and therefore there would be no additional archaeological impact.

Scour around temporary structures

7.5.11 Scour around the temporary cofferdams and campshed could have an impact upon any archaeological remains in the vicinity, eg the possible Mesolithic timber structure (HEA 1a), the visible part of which lies outside the footprint of the temporary cofferdam. The significance of any assets affected could be reduced to negligible, which would constitute a high magnitude of impact for these assets. The significance of effect on heritage assets would be as that of the cofferdams described in para. 7.5.4 above.

Above-ground heritage assets

Physical effects on above-ground heritage assets

7.5.12 In the southern part of the site around Vauxhall Bridge, the existing river outflows, dolphins, storm flaps, and granite cobbled slipways would be demolished during the construction of the southern cofferdam. The parapet of the existing unlisted river wall would be demolished to facilitate access. The below-ground section of the river wall would be removed in places to allow construction of structures through the existing river wall, and the remaining wall incorporated into the existing foreshore structure. All these assets, which are of medium significance because of their relationship with Vauxhall Bridge and the Effra outflow, would be entirely removed by the proposals. This would constitute a high magnitude of impact, resulting in a **major adverse** effect.

7.5.13 Part of the existing unlisted brick and stone 19th-century river wall would be removed to the north of Lack's Dock. This would comprise a medium magnitude of impact for this asset of medium significance, giving rise to a **moderate adverse** effect.

7.5.14 Whilst the north parapet wall of Lack's Dock would be removed temporarily this element does not contribute to the heritage significance of the dock and therefore there would be a negligible magnitude of impact for this asset of medium significance, and would result in a **negligible** effect.

7.5.15 Grade II* listed Vauxhall Bridge would be affected by ground movement during construction. The bridge would experience an approximate maximum vertical settlement of 8mm at pier three and 10mm at pier four, with the possibility of hairline cracking to a maximum of 0.1mm. No structural instability would result from the ground movement. This would constitute a negligible magnitude of change to this asset of high significance, and would therefore have a **minor adverse** effect.

Effects on the historic character, appearance and setting of above-ground heritage assets

7.5.16 The NPS recognises in paragraph 1.4.4 that nationally significant infrastructure projects are likely to take place in mature urban environments, with adverse construction effects on historic environment receptors likely to arise. Construction works similar to those proposed are commonplace in London, and therefore the following assessment should be viewed in this context. It should also be noted that construction effects are temporary in nature and, as assessed, relate to the peak construction phase. Effects during other phases of works are likely to be lower due to reduced levels of plant being required and a reduced intensity of construction activity.

Albert Embankment Conservation Area

7.5.17 The presence of construction works would detract from views from within the Albert Embankment Conservation Area towards Vauxhall Bridge. Views from the southern end of Vauxhall Bridge west towards the Millbank Conservation Area (VHV5) would be partly obscured by the presence of cranes. The construction works would not affect the historic character or appearance of the northeastern part of the Albert Embankment Conservation Area. There would be no significant effect on views from the conservation area towards the Palace of Westminster World Heritage Site. Given the limited historic character and appearance of this part of the Albert Embankment Conservation Area, the magnitude of change would be medium. This would result in a **moderate adverse** effect.

Vauxhall Bridge

7.5.18 The construction works would be directly adjacent to, and would be visible from, Vauxhall Bridge, and would detract from views northeast (VHV3) from the bridge towards the southern part of the Albert Embankment Conservation Area. The magnitude of change in relation to the setting of Vauxhall Bridge would be medium as it would only affect one end of the bridge and its relationship with other heritage assets would be largely preserved, resulting in a **moderate adverse** effect.

7.5.19 The separate townscape and visual assessment (Section 11) concludes that the works would have a major adverse effect upon the view northeast from the southern end of the bridge. The difference between the two assessments derives from their different methodologies: one considers the effect of the change upon the significance of the whole listed bridge; whereas the other considers the effect upon a specific representative view experienced by visual receptors (i.e. people) on the bridge looking towards the site itself, and includes non-heritage factors.

Millbank Conservation Area

7.5.20 The construction works would be highly visible from the river front of the Millbank Conservation Area. However, views to the site from the notable listed buildings on the far side of Millbank within the conservation area would be largely screened by the intervening presence of mature trees. The works would therefore not affect the setting of Tate Britain, Officers Mess and Commandants House in the Royal Army Medical Corps, 46-57 Millbank or the Morpeth Arms Public House. The views along the significant axis through the centre of the largely octagonal conservation area, which faces over the river from the front façade of Tate Britain, are to one side of the site and are therefore only peripherally affected. Given the broad reaching nature of views and limited contribution of this part of the Albert Embankment Conservation Area to the setting of the Millbank Conservation Area, the magnitude of change would be low, resulting in a **minor adverse** effect. The effect would be limited to the construction phase.

7.5.21 The separate townscape and visual assessment (Section 11) concludes that the works would have a major adverse effect upon the setting of the conservation area. The difference between the two assessments derives from their different methodologies: one considers the effect of the change to setting on the heritage value of the conservation area as a whole, of which only a part is affected by the proposals; whereas the other considers the effect on the townscape of a smaller area along the riverside, and includes non-heritage factors.

Vauxhall Cross

7.5.22 The construction works would detract from views towards the Vauxhall Cross from the west. The relationship between the building and its associated river frontage would be temporarily disjointed. The magnitude of change would be medium, resulting in a **minor adverse** effect.

7.5.23 The separate townscape and visual assessment (Section 11) concludes that the works would have a moderate adverse effect upon the wider character area including Vauxhall Cross. The difference between the two assessments derives from their different methodologies: one considers the effect of the change to setting upon the heritage value of the asset; whereas the other considers the effect upon the townscape of the area that contains the asset as well as other elements, and also includes non-heritage factors.

Sensitivity test to programme delay

7.5.24 For the assessment of historic environment effects during construction, a delay to the Thames Tideway Tunnel project of approximately one year would not be likely to materially change the assessment findings reported above, even if other developments were to become operational and therefore form part of the construction base case. This is because of the distance of other developments from the site and the presence of intervening structures.

7.6 Operational effects assessment

Above-ground heritage assets

Effects on the historic character, appearance and setting of above-ground heritage assets

Albert Embankment Conservation Area

7.6.1 The proposed development would be located within the conservation area beyond the line of the existing modern embankment wall adjacent to Vauxhall Bridge and the Vauxhall Cross. The replacement of the timber dolphins and sewer outfalls with the terraced structure would continue the tradition established by Bazalgette of well designed riverside sewer infrastructure along the Albert Embankment, complementing Vauxhall Bridge and the wider riverside. The development would also occupy the area to the fore of the modern office buildings to the east, which is excluded from the Albert Embankment Conservation Area, effectively extending the line of the river frontage in alignment with the Grade II Listed Embankment Wall to the east. This would alter the existing line of the embankment and introduce an element of public realm. The proposed development would be barely perceptible in views south along the river from Lambeth Bridge given the relative distance from the southern part of the Albert Embankment Conservation Area to the site. There would be no effect on views from the conservation area towards the Palace of Westminster World Heritage Site. Given the limited survival of historic character in this part of the Albert Embankment Conservation Area, the magnitude of change would be low, resulting in a **minor adverse** effect.

7.6.2 The separate townscape and visual assessment (Section 11) concludes that the works would have a minor beneficial effect upon the area. The difference between the two assessments derives from their different methodologies: one considers the effect of the change upon the heritage value of the entire conservation area, of which only a part would be affected but would lose some of its historic appearance; whereas the other considers the effect upon the townscape of a smaller area around the site itself, includes non-heritage factors, and takes account of the fact that while the area would be altered from its historic character, this change would be an improvement in terms of the quality of the townscape.

Vauxhall Bridge

7.6.3 The proposed development would include structures beneath the southern-most arch of Vauxhall Bridge and extend either side of the bridge. The sinuous design of the proposed development would contrast with the line of the bridge and formal arrangement of the adjacent embankment wall to the fore of the Vauxhall Cross, but would remain subordinate to the bridge being set considerably below the springing level of the arches. Although the proposals would alter the historic profile of the foreshore in relation to the bridge, the character of this structure, with its landscaped terraces, would be attractive in comparison to the existing timber dolphins and sewer outfalls that it would replace. The slender vent column to the south of the bridge would not significantly detract from the setting of the bridge. The magnitude of change in relation to the setting of Vauxhall Bridge would therefore be low, resulting in a **minor adverse** effect.

7.6.4 The separate townscape and visual assessment (Section 11) concludes that the works would have a moderate beneficial effect upon the setting of the listed bridge. The difference between the two assessments derives from their different methodologies: one considers the effect of the change upon the significance of the listed bridge in its setting; whereas the other considers the effect upon a particular view towards the site itself and how this is experienced by visual receptors (i.e. people), and includes non-heritage factors.

Millbank Conservation Area

7.6.5 Given the limited scale of the proposed development in views across the River Thames, there would be a very limited change to the setting of and views from the Millbank Conservation Area and its associated heritage assets. Therefore the magnitude of change in relation to the setting of the Millbank Conservation Area would negligible, resulting in a **minor adverse** effect.

Vauxhall Cross

7.6.6 Changes to the line of the river wall in the vicinity of the Vauxhall Cross building, including the connecting structure to the front of the building and drop shaft structure to the northeast beyond Lack's Dock, would be of low magnitude, resulting in a **minor adverse** effect.

7.6.7 The separate townscape and visual assessment (Section 11) concludes that the works would have a minor beneficial effect upon the townscape character around this building. The difference between the two assessments derives from their different methodologies: one considers the effect of the change upon the setting of the building in heritage terms; whereas the other considers the effect upon the townscape of a larger area that contains the asset as well as other elements, and also includes non-heritage factors.

Sensitivity test to programme delay

7.6.8 For the assessment of historic environment effects during operation, a delay to the Thames Tideway Tunnel project of approximately one year would not be likely to materially change the assessment findings reported above because of the distance of other developments from the site and the presence of intervening structures.

7.7 Cumulative effects assessment

7.7.1 None of the schemes included in the site development schedule (Vol 16 Appendix N) would have a significant cumulative effect on the historic character and setting of above-ground heritage assets during construction or operation because of the distance of these schemes from the site and the presence of intervening structures.

Sensitivity test to programme delay

7.7.2 Similarly, there would be no significant cumulative effect in the event of a programme delay to the Thames Tideway Tunnel project of approximately one year because of the distance of schemes within the development schedule (Vol 16 Appendix N). The assessment above would not be altered.

7.8 Mitigation

7.8.1 As per the NPS (para 4.10.19), a documentary record of a heritage asset is not as valuable as retaining the heritage asset, and it should not be a factor in the decision as to whether or not development consent is given, but nevertheless it is the most appropriate form of mitigation available, and in EIA terms serves to reduce the significance of the adverse effect as has been agreed with English Heritage.

Buried heritage assets

7.8.2 Based on this assessment, no heritage assets of high significance are anticipated that would merit a mitigation strategy of permanent preservation *in situ*. It is therefore considered that the minor to major environmental effects of the proposed development on buried heritage assets within the site during the construction phase could be successfully mitigated by a suitable programme of archaeological investigation before and/or during construction, to achieve preservation by record through advancing understanding of asset significance.

7.8.3 Mitigation requirements would be informed by selective site-based assessment. This could include a variety of techniques, such as geotechnical investigation, geoarchaeological deposit modelling, foreshore monitoring and survey, archaeological test pits and trial trenches. This evaluation would enable a more targeted and precise mitigation strategy to be developed for the site in advance of construction. Both evaluation and mitigation would be carried out in accordance with a scope of works (*Site Specific Archaeological Written Scheme of Investigation (SSAWSI)*, as detailed in para. 7.8.6 below.

7.8.4 Construction phase scour around the temporary cofferdams would be mitigated through a programme of monitoring and the provision of scour protection if required and agreed with the statutory consultees, as detailed in the *CoCP* Part B (Section 12).

7.8.5 Subject to the findings of any subsequent field evaluation and the detailed construction methodology employed by the contractor, mitigation of the adverse effects upon archaeological remains within the site would include the following as appropriate:

a. An archaeological watching brief during construction to mitigate impacts arising from service diversions and foundations for offices and welfare on the landward side of the existing river wall.

b. Targeted archaeological excavation within the temporary and permanent cofferdams and access ramp following the insertion of the pile walls and prior to infilling. Note that any work within the area of the ramp would be tidally constrained.

c. For works taking place below low water on the outside of the cofferdams (such as construction of the campshed and foreshore protection), an archaeological watching brief would be carried out at low tide where practical, in advance of construction. Beyond this archaeological monitoring and scanning of the arisings would be undertaken.

7.8.6 Both evaluation and mitigation would be carried out in accordance with a scope of works (*Site Specific Archaeological Written Scheme of Investigation (SSAWSI)*), based on the principles in the *Overarching Archaeological Written Scheme of Investigation (OAWSI)*, to ensure that the scope and method of fieldwork are appropriate. The *SSAWSI* would be submitted in accordance with the application for development consent (the 'application') requirement.

7.8.7 Construction phase scour around the temporary cofferdams would be mitigated through a programme of monitoring and the provision of scour protection if required, as detailed in the *CoCP* Part A (Section 12).

Above-ground heritage assets

7.8.8 The mitigation for the major adverse effect resulting from the demolition of the river outflows, dolphins and slipways would comprise a programme of standing structure survey and photographic recording, equivalent to Level 3 of the English Heritage specifications (English Heritage, 2006)[8], which would ensure a record of these assets is made prior to their removal.

7.8.9 The moderate adverse effect resulting from the demolition of part of the unlisted river wall would be mitigated through a programme of standing structure survey and photographic recording, equivalent to Level 2 or Level 3 of the English Heritage specifications (English Heritage, 2006)[9], which would ensure a record of these assets is made prior to their removal.

7.8.10 Ground movement to Vauxhall Bridge would be monitored throughout the works. Any significant damage arising from ground movement would be repaired at the end of construction, once significant ground movements have stabilised, using appropriate conservation methods to achieve a like for like repair.

7.8.11 All measures embedded in the proposed development and *CoCP* of relevance to the assessment of effects on the character and setting of above-ground heritage assets during construction are summarised in Section 7.5. No mitigation during construction is possible for significant adverse effects due to the highly visible nature of the construction activities.

7.9 Residual effects assessment

Construction effects

7.9.1 With the mitigation described above in place, the residual construction effects on above-ground and buried heritage assets within the site would be **negligible**. All residual effects are presented in Section 7.10.

7.9.2 Repair of any significant damage to Vauxhall Bridge at the end of construction would result in a **negligible** residual effect.

7.9.3 As no mitigation measures are possible for significant effects (or required for non-significant effects) on the historic character, appearance and setting of above-ground heritage assets beyond those embedded in the proposed development and *CoCP*, the residual construction effects on the setting of heritage assets remain as described in Section 7.5. All residual effects are presented in Section 7.10.

Operational effects

7.9.4 As no mitigation measures are required for effects on the historic character, appearance and setting of above-ground heritage assets, the residual operational effects on the setting of heritage assets remain as described in Section 7.6. All residual effects are presented in Section 7.10.

7.10 Assessment summary

7.10.1 Two access options have been considered: Option A would be via Lack's Dock and Option B would involve the construction of a temporary road access between Camelford House and Tintagel House. There is no material difference in terms of historic environment effects between the two schemes and the effects are not reported separately.

Vol 16 Table 7.10.1 Historic environment – summary of construction assessment

Receptor (Heritage asset)	Effect	Significance of effect	Mitigation	Significance of residual effect
Buried heritage assets				
High potential for prehistoric remains, including a possible Mesolithic timber structure and land surfaces including associated palaeoenvironmental remains (High asset significance)	Assets affected by construction of the cofferdams, access ramp, campshed, scour protection, and CSO drop shaft and chambers. Assets removed by scour around temporary cofferdams. Asset significance reduced to negligible.	Major adverse	Targeted archaeological investigation and recording. Monitoring of scour and provision of scour protection if required and agreed with statutory consultees.	Negligible
Setting of Mesolithic and other prehistoric timber structures (Medium asset significance)	Assets affected by construction of the cofferdams, access ramp, campshed, scour protection, and CSO drop shaft and chambers. Assets removed by scour around temporary cofferdams. Asset significance reduced to negligible.	Major adverse	Topographic and geoarchaeological deposit modelling. Monitoring of scour and provision of scour protection if required and agreed with statutory consultees. Parts of asset would remain on Thames foreshore.	Negligible

Receptor (Heritage asset)	Effect	Significance of effect	Mitigation	Significance of residual effect
Low potential for isolated Roman artefacts (Low asset significance)	Assets affected by construction of the cofferdams, access ramp, campshed, scour protection, and CSO drop shaft and chambers. Assets removed by scour around temporary cofferdams. Asset significance reduced to negligible.	Minor adverse	Targeted archaeological investigation and recording. Monitoring of scour and provision of scour protection if required and agreed with statutory consultees.	Negligible
Low potential for isolated early medieval artefacts (Low asset significance)	Assets affected by construction of the cofferdams, access ramp, campshed, scour protection, and CSO drop shaft and chambers. Assets removed by scour around temporary cofferdams. Asset significance reduced to negligible.	Minor adverse	Targeted archaeological investigation and recording. Monitoring of scour and provision of scour protection if required and agreed with statutory consultees.	Negligible
Low potential for later medieval remains of a possible ferry or waterfront structures (Low asset significance)	Assets affected by construction of the cofferdams, access ramp, campshed, scour protection, and CSO drop shaft and chambers. Assets removed by scour around temporary cofferdams. Asset significance reduced to negligible.	Minor adverse	Targeted archaeological investigation and recording. Monitoring of scour and provision of scour protection if required and agreed with statutory consultees.	Negligible

Receptor (Heritage asset)	Effect	Significance of effect	Mitigation	Significance of residual effect
High potential for post-medieval remains, comprising industrial remains (Low asset significance)	Assets potentially removed by site setup activities. Asset significance reduced to negligible.	Minor adverse	Archaeological watching brief. Monitoring of scour and provision of scour protection if required and agreed with statutory consultees.	Negligible
	Assets affected by construction of the cofferdams, access ramp, campshed, scour protection, and CSO drop shaft and chambers. Assets removed by scour around temporary cofferdams. Asset significance reduced to negligible.	Minor adverse	Targeted archaeological investigation and recording. Monitoring of scour and provision of scour protection if required and agreed with statutory consultees.	Negligible
Above-ground heritage assets				
Post-medieval river outflows, dolphins, storm flaps and brick slipways (Medium asset significance)	Removal of assets. Asset significance reduced to negligible.	Major adverse	Programme of archaeological survey, recording and photography to ensure the assets are not removed without record.	Negligible
Existing unlisted river wall on the site (Medium asset significance)	Removal of sections of river wall and parapet and obscuring of the underlying river wall and its alignment in these areas.	Moderate adverse		Negligible
Lack's Dock	Removal of modern parapet wall	Negligible	None.	Negligible

Receptor (Heritage asset)	Effect	Significance of effect	Mitigation	Significance of residual effect
(Medium asset significance; modern parapet wall of negligible significance)				
Albert Embankment Conservation Area (High asset significance)	The construction works would detract from views within part of the Albert Embankment Conservation Area southwest towards Vauxhall Bridge. Views from the eastern end of Vauxhall Bridge northwest towards the Millbank Conservation Area would be partly obscured. Overall there would be a medium effect upon this asset of high significance.	Moderate adverse	No mitigation possible further to that embodied within the proposed design and the *CoCP* and environmental design principles.	Moderate adverse
Vauxhall Bridge (High asset significance)	The proposed development would detract slightly from views to the eastern abutment of the bridge from the northern end of Albert Embankment Conservation Area.	Moderate adverse	No mitigation possible further to that embodied within the proposed design and the *CoCP* and environmental design principles.	Moderate adverse
	Ground movement resulting from construction works is predicted to result in a negligible damage risk, typically with hairline cracks up to 0.1mm	Minor adverse	The structure would be monitored throughout construction, and any significant damage repaired using appropriate conservation techniques	Negligible
Millbank Conservation Area	The setting of the Millbank	Minor adverse	No mitigation required	Minor adverse

Receptor (Heritage asset)	Effect	Significance of effect	Mitigation	Significance of residual effect
(High asset significance)	Conservation Area would be partially screened from views of construction activity by the presence of intervening vegetation.		further to that embodied within the proposed design and the *CoCP* and environmental design principles.	
Vauxhall Cross (Low asset significance)	Views from the west and the relationship between the building and its associated river frontage would be temporarily disjointed.	Minor adverse	No mitigation required further to that embodied within the proposed design and the *CoCP* and environmental design principles.	Minor adverse

Vol 16 Table 7.10.2 Historic environment – summary of operational assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Albert Embankment Conservation Area (High asset significance)	Given the relative distance from the northern part of the Albert Embankment Conservation Area to the site, the proposed development would be barely perceptible in views along the river, although it would change the historic profile of the foreshore.	Minor adverse	No mitigation required further to that embodied within the proposed design and environmental design principles	Minor adverse
Vauxhall Bridge (High asset significance)	The design of the proposed development would contrast with the line of the bridge and formal arrangement of the adjacent embankment wall to the fore of the Vauxhall Cross, but would not significantly affect the setting of the bridge.	Minor adverse	No mitigation required further to that embodied within the proposed design and environmental design principles	Minor adverse
Millbank Conservation Area (High asset significance)	Given the scale of the proposed development in relation to the viewing distance across the River Thames, there would be a negligible change to the setting of or views from the Millbank Conservation Area.	Minor adverse	No mitigation required further to that embodied within the proposed design and environmental design principles	Minor adverse
Vauxhall Cross (Low asset significance)	Changes to the line of the river wall would be of low magnitude.	Minor adverse	No mitigation required further to that embodied within the proposed design and environmental design principles	Minor adverse

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[7] London Borough of Lambeth. *Designation of the Albert Conservation Area CA57*, 3.51 (2001).

[8] English Heritage. *Understanding historic buildings: a guide to good recording practice*. Swindon (2006).

[9] English Heritage, 2006. *See citation above*.

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

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Volume 16: Albert Embankment Foreshore site assessment

Section 8: Land quality

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Thames Tideway Tunnel

Environmental Statement

Volume 16: Albert Embankment Foreshore site assessment

Section 8: Land quality

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8 Land quality

8.1 Introduction

8.1.1 This section presents the findings of the assessment of the likely significant land quality effects of the proposed development at the Albert Embankment Foreshore site.

8.1.2 The scope of the land quality assessment is to:

a. describe the condition of the site in terms of contaminant history and likely presence and magnitude of soil/sediment and liquid contamination (such as groundwater or perched water within the Made Ground), in addition to unexploded ordnance (UXO) and the presence of Japanese Knotweed, an invasive plant species which can be regarded as a soil contaminant.

b. describe and assess the impacts and significant effects of the interaction between these contaminants and the built environment, human and environmental receptors as a result of construction of the proposed development (taking into account any embedded measures).

8.1.3 There are a number of interfaces between land quality and other topic sections, as summarised below:

a. Section 13 Water resources – groundwater assesses the likely significant effects to water resources from soil, perched water and groundwater contamination. The land quality assessment considers potential risks to human health receptors (eg, construction workers) from contaminated perched water and groundwater, including free phase[i] contamination.

b. Section 4 Air quality and odour assesses the likely significant effects to the air quality during the construction and operation of the site. The land quality assessment considers potential risks from, for example, the generation of dust and soil vapour from exposed ground and soils during construction.

c. Section 5 Ecology – aquatic and Section 14 Water resources – surface water, these sections consider the mobilisation of sediments associated with in-river construction. The surface water section also considers the likely significant effects to controlled waters from land contamination (eg, contaminated run-off) and use of contaminating substances during construction. No further assessment of these impacts and effects is made in the land quality section.

[i] Free phase contamination – hydrocarbons that form a discrete layer within groundwater, either floating on the groundwater surface or at the base of a groundwater body.

8.1.4 Operational land quality effects for this site have not been assessed. This is on the basis of the embedded measures adopted during the construction and operational phases (refer to Section 8.2 and Vol 2 Section 8.6). No significant operational effects are considered likely and for this reason, only information relating to construction is presented in the assessment of effects on land quality.

8.1.5 Two access options have been considered: Option A is via Lack's Dock and Option B involves the construction of a temporary road access between Camelford House and Tintagel House. Neither option would alter the assessment of likely significant land quality effects as they would not impact on land quality at the Albert Embankment Foreshore Site. The options are therefore not presented or reported separately for this topic.

8.1.6 The assessment of the likely significant effects of the project on land quality has considered the requirements of the National Policy Statement for Waste Water (Defra, 2012)[1] section 4.8. The risk posed by construction on previously developed land is addressed in the following assessment and through measures embedded in the *Code of Construction Practice* (*CoCP*) (further details can be found in Vol 2 Section 8, Vol 2 Table 8.3.1). The *CoCP* is provided in Vol 1 Appendix A. It contains general requirements (Part A), and site specific requirements for this site (Part B).

8.1.7 Plans of the proposed development as well as figures included in the assessment for this site are contained in a separate volume (Volume 16 Albert Embankment Foreshore Figures).

8.2 Proposed development relevant to land quality

8.2.1 The proposed development is described in Section 3 of this volume. The elements of the proposed development relevant to land quality are set out below.

Construction

8.2.2 The elements of the proposed development relevant to land quality would consist of the following:

a. dredging and construction of two temporary cofferdams and construction of campsheds adjacent to the cofferdams

b. partial demolition of an existing river wall, construction of new river wall and removal and replacement of CSO outfall aprons

c. construction of pits, chambers, ducts and pipes for cables, pipes, utility connections and diversions and drainage

d. construction of an offline combined sewer overflow (CSO) drop shaft, the invert of which would be located at a depth of approximately 47m below ground level (bgl), within the Lambeth Group (Upnor Formation)

e. Clapham storm relief CSO and Brixton storm relief CSO interception works and associated excavation works

f. Clapham/Brixton connection tunnel from the drop shaft to the main tunnel

g. construction of an interception chamber, CSO overflow, weir and culverts and other hydraulic structures

h. construction of structures for air management plant and equipment including filter and ventilation columns and associated below ground ducts and chambers.

8.2.3 The above works would involve extensive below ground construction, resulting in the excavation and removal of material, including natural soils.

8.2.4 An area would also be required within the site for construction logistics, such as materials handling and storage areas, segment storage, site welfare facilities and offices (as shown in Vol 16 Albert Embankment Foreshore site Construction plans, see separate volume of figures).

Code of Construction Practice

8.2.5 The embedded design measures relevant to land quality at the site are set out in Section 9 of the *CoCP* and are summarised below. Reference should be made to the *CoCP* Part A (Section 9) for full details.

8.2.6 There are no site specific *CoCP* measures which are relevant to this land quality assessment.

8.2.7 Land quality issues would be managed in close liaison with the local authority, London Borough (LB) of Lambeth and the Environment Agency (EA) prior to and during construction.

Pre-construction

8.2.8 The proposed development has been characterised and assessed with respect to land quality through the application of the following steps (which are dictated by the regulatory framework outlined in Section 9 of the *CoCP*):

a. completion of a desk study which includes a review of available information sources (see Vol 16 Appendix F.1) as well as review of site specific ground investigation data and the production of an initial conceptual site model

b. undertaking of specialist site surveys, such as Japanese Knotweed and UXO, which to date has included a site-specific desk study for part of the Albert Embankment Foreshore site to inform ground investigation work (see Vol 16 Appendix F.2).

8.2.9 In view of the results of the preliminary ground investigation and the low risk current land use (River Thames foreshore and Lacks Dock access and slipway), and that main construction works would take place within the foreshore, it is judged that specific remediation works for land quality purposes in advance of the main construction works would be unnecessary.

8.2.10 It is anticipated that the information used to produce this *Environmental Statement* would be reformatted into a preliminary risk assessment compliant with the guidance set out in BS10175 (British Standards Institution, 2011)[2] and CLR11 Model procedures for the management of land contamination (EA, 2004)[3] for submission to the regulators prior to construction works.

Construction

8.2.11 Health and safety measures for the protection of construction workers with respect to land quality issues would include:

a. the provision of adequate training for all construction site workers to recognise and appropriately respond to potential land quality issues

b. site welfare facilities and where appropriate, decontamination units (ie, dirty in, clean out welfare units)

c. use of standard construction site personal protective equipment (PPE) (eg, high visibility clothing, safety boots, hard hat, safety glasses gloves and respiratory equipment)

d. robust emergency procedures (eg, with respect to UXO, previously unidentified contamination or structures), which are periodically reviewed. In the event of previously unidentified conditions being encountered, works would be suspended, the work area evacuated and specialist advice obtained. Where appropriate, risk assessments would be undertaken and additional control measures implemented prior to any works recommencing.

8.2.12 During construction, effective material management procedures, such as the storage and handling of excavated soils, fuels and other chemicals (as detailed further in the surface water section of the *CoCP*), would be implemented. Excavated materials with the potential to be contaminated would be removed from site as soon as practicable. Site control measures would be implemented to reduce dust (see air quality section of the *CoCP*) and the spread of mud by vehicles (see public access, the highway and river transport section of the *CoCP*).

8.2.13 Environmental monitoring, would include the following measures:

a. on-site watching brief during potentially high risk activities and an on call watching brief for all other activities. Specialist watching brief may include: UXO; contaminated land; health and safety/occupational health; and ecological (for invasive species, such as Japanese Knotweed)

b. dust and air/vapour monitoring (see Section 9 of the *CoCP* for further details). Where appropriate, this would include a combination of on-site and boundary monitoring.

8.3 Assessment methodology

Engagement

8.3.1 Volume 2 Environmental assessment methodology documents the overall engagement which has been undertaken in preparing the *Environmental Statement*. Specific comments relevant to this site for the assessment of land quality are presented here.

8.3.2 The LB Lambeth were specifically consulted with respect to any land quality data they hold at the site and surrounding area. The LB Lambeth confirmed that they had no land quality data within the site or search area.

Baseline

8.3.3 The baseline methodology follows the methodology described in Vol 2. There are no site-specific variations for identifying the baseline conditions for this site

Construction

8.3.4 The assessment methodology for the construction phase follows that described in Vol 2. There are no site-specific variations for undertaking the construction assessment of this site.

8.3.5 The construction assessment area considered for the assessment of land quality includes the limits of land to be acquired or used (LLAU) plus an additional 250m buffer area. This assessment area has been selected in order to take account of any off-site sources that could impact on the land quality of the site as well as any nearby sensitive receptors.

8.3.6 The construction assessment has been undertaken for Site Year 1 of the construction phase.

8.3.7 The base case and cumulative assessment in Site Year 1 of construction take into account the schemes described in Vol 16 Appendix N. The baseline is expected to change between the base case year and Site Year 1 of construction (2017). There are three developments within the 250m buffer area (as shown in Vol 16 Table 8.3.1) which are likely to be complete and operational before the commencement of the construction phase and as a result form part of the construction base case.

8.3.8 The developments within the 250m buffer area which are not considered as part of the construction base case are those developed during and after Site Year 1 of construction, these are included within the cumulative effects assessment and are also identified in Vol 16 Table 8.3.1.

Vol 16 Table 8.3.1 Land quality – construction base case and cumulative assessment development (2017)

Development	Distance from site	Construction base case	Cumulative impact assessment
2-14 Tinworth Street and 108-110 Vauxhall Walk (redevelopment of existing developments to provide a mixed scheme comprising hotel, accommodation, retail store, small business units, community centre and public realm area)	120m northeast	✓	✗
Eastbury House, 30 - 34 Albert Embankment (demolition of the existing building and the erection of a part 14, part 21, part 28 storey building to provide a mixed use scheme incorporating: ground floor cafe/retail unit and public piazza, office	150m northeast	✓	✗

Development	Distance from site	Construction base case	Cumulative impact assessment
accommodation and residential units)			
1-9 Bondway and 4-6 South Lambeth Place (redevelopment of the site involving the demolition of the existing buildings and the erection of a 6 storey building (plus lower ground floor level) to provide a hotel with ancillary bar/restaurant facilities along with commercial floorspace (retail, financial and professional services and cafes/drinking establishments)	185m southeast	✓	✗
Land at St Georges Wharf, Vauxhall Tower (redevelopment of part of St Georges Wharf to provide residential accommodation, office and retail space, leisure facilities and riverside walkway)	200m south	✓	✗
Hampton House, 20 Albert Embankment, London (demolition of existing building and development of mixed use buildings comprising commercial and residential units with landscaping)	230m northeast	✓	✗
Vauxhall Square, Parry Street, Bondway, Miles Street and Wandsworth Road (demolition of existing buildings and development of a mixed use scheme comprising residential, office, retail and leisure uses in addition to public realm improvements)	250m south	✗	✓

Symbols ✓ applies ✗ does not apply

8.3.9 Section 8.5 details the likely significant effects arising from the construction at the Albert Embankment Foreshore site. There are no other Thames Tideway Tunnel project sites which could give rise to additional effects on land quality within the assessment area for this site, therefore no other Thames Tideway Tunnel project sites are considered in this assessment.

Development of conceptual model

8.3.10 The assessment of land quality effects is based on the development of a source-pathway-receptor (SPR) conceptual model. This model aims to understand the presence and significance of potentially complete pollutant linkages.

8.3.11 The SPR conceptual model is based on guidance given in CLR113. This type of assessment specifically relates to risk assessment and management of land contamination and has been used to inform the environmental impact assessment (EIA) which seeks to identify the likely significant effects of the proposed development.

8.3.12 The impact assessment considers the anticipated level of contamination likely during Site Year 1 of construction using the categories of receptor sensitivity and impact magnitude described in Vol 2 Section 8.4 and Vol 2 Section 8.5 respectively.

8.3.13 The significance of effects has been determined using the generic matrix given in Vol 2 Section 3.7. A description of the significance criteria is presented in Vol 2 Section 8.5.

8.3.14 The methodology for undertaking both source-pathway-receptor analysis and the impact assessment is provided in Vol 2 Section 8.

Assumptions and limitations

8.3.15 The assumptions and limitations associated with this assessment are presented in Vol 2. Assumptions and limitations specific to the site are detailed below.

Assumptions

8.3.16 There are no assumptions specific to the Albert Embankment Foreshore site.

Limitations

8.3.17 There is limited site specific ground investigation data within some parts of the limits of land to be acquired and used. It is however, considered that there is sufficient information currently available to provide a robust assessment.

8.4 Baseline conditions

8.4.1 The following section sets out the baseline conditions for land quality within and around the site. Future baseline conditions (base case) are also described.

Current baseline

Introduction

8.4.2 A full list of the data sets used in this assessment is presented in Vol 2.

8.4.3 A baseline report is presented in Vol 16 Appendix F.1 which details the data obtained for this site and identifies the contamination sources that may have affected the site. In addition to Vol 16 Appendix F.1, this section should also be read in conjunction with Vol 16 Figure F.1.1, Vol 16 Figure F.1.2 and Vol 16 Figure F.1.3 (see separate volume of figures).

Summary of baseline conditions

Geology

8.4.4 The site is underlain by a cover of Alluvium extending to 1.2m bgl. This is underlain (in turn) by River Terrace Deposits, London Clay Formation, Harwich Formation and Lambeth Group (see Vol 16 Appendix F.1, Vol 16 Table F.3 for the full geological succession).

Contamination

8.4.5 The majority of the area within the LLAU (operation area and the site) comprises the River Thames foreshore and has not been subject to major contaminative history.

8.4.6 The eastern edge of the site and land beyond was formerly occupied by a number of potentially contaminating activities, notably dock, gas works and oil works (the latter were present up to approximately 1967). In addition an existing fuel station is located 25m to the south east.

8.4.7 The Thames foreshore sediments along the tidal reaches have been found to contain low levels of polycyclic aromatic hydrocarbons (PAHs) and metals from historic activities within the wider River Thames and coliforms from sewage discharges (see the *Sediment sampling report* which forms Vol 2 Appendix F.2).

8.4.8 The levels of various potential contaminants in the sediments are relatively low in terms of risk to human health and are relatively immobile (not readily leachable). These sediments are also restricted to the upper part of the proposed excavation works (less than one metre in thickness).

8.4.9 The remains a possibility that residual contamination from previous and existing activities on and adjacent to the site may have impacted the River Terrace Deposits that are located at a shallow depth beneath the site (and are less than 3m in thickness). The potentially contaminating activities and associated substances are presented in Vol 2 Appendix F.2, Vol 2 Table F.2.

8.4.10 Contamination, if any, would be in limited vertical extent by the London Clay Formation and the majority of the excavated materials at the site from the CSO drop shaft would therefore be essentially uncontaminated.

UXO

8.4.11 A desk based assessment for UXO threat was undertaken for ground investigation works at the proposed development site (see Vol 16 Appendix F.2). The report reviews information sources such as the Ministry of Defence (MoD), Public Records Office and the Port of London Authority (PLA).

8.4.12 The study site is located in the LB of Lambeth an area that experienced high levels of bombing during World War II. One high explosive bomb is recorded as landing directly within the study site boundary, with a further two landing within a 50m buffer zone and potential for many of landing unnoticed within the river itself.

8.4.13 The site was therefore given a high risk rating.

Summary of receptors

8.4.14 The receptors identified at this site from the baseline survey (see Vol 16 Appendix F.1) and their corresponding sensitivity following the criteria set out in Vol 2 are as follows:

a. construction workers: low sensitivity for general above ground site workers, such as staff in site offices or delivery drivers and high sensitivity for those site workers involved in below ground excavation works and associated activities

b. adjacent land-users: residential land-users and educational land-users (high sensitivity), recreational land-users within the Albert Embankment Gardens (medium sensitivity) and adjacent light industrial/ commercial land-users and Thames Path users (low sensitivity)

c. built environment: listed structures such as the Vauxhall Bridge and associated benches and river wall (high sensitivity), light industrial, commercial, residential and educational properties and non listed section of river wall (low sensitivity).

Construction base case

8.4.15 For land quality, the assessment of construction effects is based on the conditions which are likely to be experienced in Site Year 1 of construction (base case).

8.5 Construction effects assessment

Construction assessment case

8.5.1 Land quality baseline conditions are unlikely to have changed from those described above by the commencement of the construction phase. This is primarily due to the majority of works being located within the foreshore environment which would not be subject to remediation prior to commencement of construction.

Development of conceptual model

Interactions between source-pathway-receptor

8.5.2 The following section outlines how the contamination sources summarised in paras. 8.4.5 to 8.4.10 may interact with the receptors identified during the construction phase (see para. 8.4.14) following the application of the embedded measures (see Section 8.2).

8.5.3 The main land quality SPR interactions are considered to be from the exposure of potential contamination to:

a. Construction workers (receptor) via dermal contact, ingestion, inhalation of dust and soil vapours/soil gas and direct contact

b. Adjacent land-users, including members of the public (receptor) via off-site migration of soil vapour (by diffusion or due to wind) and wind-blown dust contaminant pathways as well as accidental UXO detonation

c. The built environment (on and off-site receptors) via the accidental detonation of previously unidentified UXO.

8.5.4 The SPR interactions are summarised in Vol 16 Table 8.5.1. For simplicity the various sources identified have been grouped together into the different phases which they may be found (ie, solid, liquid, and gaseous), as these interact with receptors in a similar manner.

Vol 16 Table 8.5.1 Land quality – source-pathway-receptor summary (construction)

Receptors / Generic sources	Construction workers	Adjacent land-users	Built environment
Contaminated soils/ sediments	Inhalation, dermal contact, ingestion	Wind -blown dust, inhalation, vapour migration (and subsequent ingestion or inhalation)	N/A
UXO	UXO detonation	UXO detonation	UXO detonation

N/A =Not applicable

Impacts and effects

8.5.5 The following section discusses the potential impacts and likely significant effects on receptors as a result of the land quality conditions at the site.

8.5.6 The assessment focuses on those linkages between sources, pathways and receptors that could generate significant effects and is based on available information and professional judgement.

Construction workers

8.5.7 A number of embedded measures set out in the *CoCP* (Section 9) are designed to effectively manage any potential land quality impacts to construction workers associated with the construction phase of the proposed development (measures are summarised in Section 8.2).

Contamination

8.5.8 The management of contamination at the site is a two stage process, the first stage comprises the assessment, quantification and if necessary the removal of the main contamination sources which could impact upon construction worker health.

8.5.9 The second stage comprises safe methods of work and management of contamination during construction (assuming that some contaminated soils could remain, or previously unidentified contamination be found, during the main construction works).

8.5.10 Both of these stages include measures such as site-specific risk assessments, watching brief, safe methods of work, use of PPE and mitigation from a specialist contractor who is experienced at managing such risks.

8.5.11 With these measures in place, the overall magnitude of the impact to construction workers (both below and above ground) is assessed to be negligible.

8.5.12 This would result in a **negligible** effect on above ground construction workers and a **minor adverse** effect on those involved in intensive below ground works (although the effect is defined as minor adverse, it is considered unlikely that the effects would occur).

UXO

8.5.13 The management of UXO risk comprises advice from a specialist contractor who is experienced at managing such risks. This would include an initial assessment of UXO being present at the site (such as that already undertaken) and a proportional response to this risk. With a high risk site such as Albert Embankment Foreshore, this is likely to include of site-specific risk assessments, safe methods of work/tool box talks and emergency response procedure as well as a UXO watching brief as excavations progress.

8.5.14 These measures are successfully utilised in major construction schemes within London on regular basis. Therefore with these measures in place, the overall magnitude of the impact to construction workers (both below and above ground) is assessed to be negligible.

8.5.15 This would result in a **negligible** effect on above ground construction workers and a **minor adverse** effect on those involved in intensive below ground works (although the effect is defined as minor adverse, it is considered unlikely that the effects would occur).

Adjacent land-users

Contamination

8.5.16 Impacts on adjacent land-users could occur via excavation and exposure of previously unidentified contaminated soils (which would be restricted solely to excavations within the shallow River Terrace Deposits). This contamination could then migrate onto neighbouring sites. The pathways via which the contamination could migrate are: wind-blown dust and vapour diffusion.

8.5.17 A number of embedded measures set out in the *CoCP* (Section 9), as summarised in Section 8.2, are designed to effectively manage any land quality impacts to the adjacent land-users associated with the construction phase of the proposed development.

8.5.18 These measures include:

a. the damping down of excavations, storage of potentially contaminated soils in secure (covered) areas, wheel washes at site entrance and the maintenance, construction and cleaning of hardstanding

b. dust and air/vapour monitoring to provide a check that volatile contamination or construction dusts do not significantly affect adjacent land users. Where appropriate, this would include a combination of on-site and boundary monitoring, which would provide either real time measurements or collect samples for subsequent analysis. For further detail and guidance reference should be made to the *CoCP* Part A (Section 9).

8.5.19 With these measures in place the overall magnitude of the impact to all adjacent land-users is assessed to be negligible.

8.5.20 Based on the assessed impact magnitude and receptor sensitivity, it is considered that the proposed development would result in a **negligible** effect on the adjacent light industrial or commercial land-users, Thames Path users and recreational users such as those within Albert Embankment Gardens and a **minor adverse** effect on the residential and educational land-users (although the effect is defined as minor adverse, it is considered unlikely that the effects would occur).

UXO

8.5.21 Impacts on adjacent land-users could occur via accidental detonation of UXO during below ground works. The embedded measures are set out in the *CoCP* (Section 9), such as the use of specialised UXO contractors offering site-specific advice and where necessary on-site monitoring. These measures are designed to effectively manage any impacts to the adjacent land-users associated with the construction phase of the proposed development.

8.5.22 With these measures in place the overall magnitude of the impact to all adjacent land-users is assessed to be negligible.

8.5.23 Based on the assessed impact magnitude and receptor sensitivity, it is considered that the proposed development would result in a **negligible** effect on the adjacent light industrial or commercial land-users, Thames Path users and recreational users such as those within Albert Embankment Gardens and a **minor adverse** effect on the residential and educational land-users (although the effect is defined as minor adverse, it is considered unlikely that the effects would occur).

Built environment

8.5.24 Impacts from existing land quality relate to the accidental detonation of UXO during preliminary surveys or main construction works.

8.5.25 A number of embedded design measures set out in the *CoCP* (Section 9), as summarised in Section 8.2, are designed to effectively manage any land quality impacts (eg, from UXO) to the built environment associated with the construction phase of the proposed development.

8.5.26 With these measures in place the overall magnitude of the impact to the built environment is assessed to be negligible.

8.5.27 Based on the assessed impact magnitude and receptor sensitivity, it is considered that the proposed development would result in a **negligible** effect on the adjacent light industrial, commercial, residential and educational properties and non listed river wall and **minor adverse** effect on the listed structures, such as the Vauxhall Bridge and associated benches and river wall (although the effect is defined as minor adverse, it is considered unlikely that the effects would occur).

8.6 Operational effects assessment

8.6.1 Operational effects have not been assessed for land quality (see para. 8.1.4).

8.7 Cumulative effects assessment

8.7.1 Of the projects described in Vol 16 Appendix N, which could potentially give rise to cumulative effects with the proposed development at Albert Embankment Foreshore, one development has been identified (see Vol 16 Table 8.3.1).

8.7.2 No cumulative land quality effects are expected during the construction of the Thames Tideway Tunnel project, since impacts are constrained to the footprint of the development by the measures incorporated in the *CoCP* (Section 9).

8.8 Mitigation

8.8.1 The assessment presented above does not identify the need for mitigation during construction over and above those measures set out in the *CoCP* (Section 9). No further mitigation, enhancement or monitoring is required.

8.9 Residual effects assessment

8.9.1 As no mitigation measures are proposed, the residual construction effects remain as described in Section 8.5. All residual effects are presented in Section 8.10.

8.10 Assessment summary

Vol 16 Table 8.10.1 Land quality – summary of construction assessment

Receptor (sensitivity)	Effect	Significance of effect	Mitigation	Significance of residual effect
Construction workers – general above ground site staff (Low)	Health effects from exposure to contaminated soils, liquids, sediment, soil gases/vapours	Negligible	None	Negligible
	Health effects from detonation of UXO	Negligible	None	Negligible
Construction workers – below ground site staff (High)	Health effects from exposure to contaminated soils, liquids, sediment, soil gases/vapours	Minor adverse	None	Minor adverse*
	Health effects from detonation of UXO	Minor adverse	None	Minor adverse*
Adjacent land-users, workers within the light industrial/commercial properties and Thames Path users (Low)	Health effects from exposure to wind-blown dust or vapours	Negligible	None	Negligible
	Health effects from detonation of UXO	Negligible	None	Negligible
Adjacent land-users, recreational uses such as those within Albert Embankment Gardens (Medium)	Health effects from exposure to wind-blown dust or vapours	Negligible	None	Negligible
	Health effects from detonation of UXO	Negligible	None	Negligible
Adjacent land-users, residential and educational land-users (High)	Health effects from exposure to wind-blown dust or vapours	Minor adverse	None	Minor adverse*
	Health effects from detonation of UXO	Minor adverse	None	Minor adverse*
Built environment – Surrounding commercial, light	Damage to structures caused by detonation of UXO	Negligible	None	Negligible

Receptor (sensitivity)	Effect	Significance of effect	Mitigation	Significance of residual effect
industrial and residential and educational properties and non listed river wall (Low)				
Built environment – listed Structures, such as Vauxhall Bridge and associated benches and river wall (High)	Damage to structures caused by detonation of UXO	Minor adverse	None	Minor adverse*

**Although the effect is minor adverse, it is considered unlikely that the effect would occur.*

References

[1] Defra. *National Policy Statement for Waste Water* (2012).

[2] British Standards Institution. *BS10175 Investigation of potentially contaminated sites: Code of Practice* (2011).

[3] Environment Agency. *Model procedures for the management of land contamination: Contaminated Land Report 11* (2004).

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

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Volume 16: Albert Embankment Foreshore site assessment

Section 9: Noise and vibration

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Environmental Statement

Volume 16: Albert Embankment Foreshore site assessment

Section 9: Noise and vibration

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9 Noise and vibration

9.1 Introduction

9.1.1 This section presents the findings of the assessment of the likely significant effects on noise and vibration at the Albert Embankment Foreshore site.

9.1.2 The proposed development has the potential to affect noise and vibration levels at receptors due to:

a. construction site activities (noise and vibration)

b. construction traffic on roads outside the site (noise)

c. tugs pulling river barges conveying materials to and from the site (noise)

d. operation of the proposed development (noise and vibration).

9.1.3 Each of these is considered within the assessment.

9.1.4 The tunnel drive for the main tunnel does not run beneath this location. Groundborne noise and vibration from the tunnelling activities associated with the main tunnel, long connection tunnels and certain short connection tunnels are considered in Volume 3 Project-wide assessment[i].

9.1.5 The assessment of noise and vibration presented in this section has considered the requirements of the National Policy Statement for Waste Water Section 4.9 (noise and vibration). Further details of these requirements can be found in Volume 2 Environmental assessment methodology Section 9.3.

9.1.6 Plans of the proposed development as well as figures included in the assessment for this site are contained in a separate volume (Volume 16 Albert Embankment Foreshore figures).

9.2 Proposed development relevant to noise and vibration

9.2.1 The proposed development is described in Section 3 of this volume. The elements of the proposed development relevant to noise and vibration are set out below.

[i] Surface activities to facilitate construction of the short connection tunnel are considered within this assessment. Construction of the short connection tunnel at this site is not considered within Volume 3 as the connection tunnel would be constructed beneath the river away from sensitive receptors and effects from groundborne noise and vibration are therefore not considered likely.

Construction

Construction traffic

9.2.2 During construction cofferdam fill (both import and export), shaft and other excavated material (export) would be transported by barge. For the noise assessment it has been assumed that 90% of these materials would be taken by river. This allows for periods when the river is unavailable and material unsuitable for river transport. All other materials would be transported by road. Estimated barge and vehicle numbers are presented in Vol 16 Sections 3.3 and 12.2.

9.2.3 The assessment considers the effects of both the access options presented in Vol 16 Section 2. The results of the assessment of Option A are presented first, followed by Option B.

Construction activities

9.2.4 Vol 16 Section 3.3 sets out the assumed construction duration and programme for the Albert Embankment Foreshore site.

9.2.5 The construction works at this location would involve the following activities that have the potential to affect noise and vibration levels in the vicinity of the site:

a. utility diversions

b. hoarding and site setup

c. demolition and site clearance

d. cofferdam construction

e. diaphragm wall construction

f. shaft construction

g. shaft secondary lining

h. connection tunnel

i. interception works including culvert works, chambers and air management structures

j. landscaping (including construction and fit-out of permanent facility).

9.2.6 Further detail on the plant used in these construction stages is given in Vol 16 Appendix G.

9.2.7 Working hours have been subject to consultation with the local authority. As part of the *Code of Construction Practice (CoCP)* requirements, Section 61 consents would be agreed with the local authority to confirm methodologies. Construction activities would be carried out during the following periods, as identified in the *CoCP*:

a. standard hours (08.00-18.00 weekdays and 08.00-13.00 Saturdays).

b. extended working hours (18.00-22.00 weekdays, 13.00-17.00 Saturdays) to complete large concrete pours. These are assumed to occur approximately twice a week for four months during the diaphragm walling works and then once a month for other major concrete pours.

c. continuous working (24 hours a day, 7 days a week) for construction of the short connection tunnel from the shaft to the main tunnel. This would be carried out over a period of approximately three months.

Code of Construction Practice

9.2.8 The *CoCP* is provided in Vol 1 Appendix A. It contains general requirements (Part A), and site specific requirements for this site (Part B).

9.2.9 The *CoCP Part A* (Sections 4.3 and 6.4) specifies the use of best practicable means (BPM) to reduce noise and vibration effects. Generic measures include:

a. careful selection of construction plant construction methods and programming

b. equipment would be suitably sited so as to minimise noise impact on sensitive receptors

c. use of site enclosures, and temporary stockpiles to provide acoustic screening

d. choice of routes and programming for the transportation of construction materials, excavated material and personnel to and from the site

e. careful programming so that activities which may generate significant noise would be planned with regard to local occupants and sensitive receptors

f. hoarding would be of a height and extent to achieve appropriate noise attenuation.

9.2.10 Site specific measures have been incorporated into the *CoCP Part B* (sections 4 and 6) to reduce noise and vibration effects at Albert Embankment Foreshore. These comprise:

a. site hoarding would be 3.6m high

b. the use of low vibration piling, eg. hydraulic jacking/hydraulic press methods, are required for the construction of the cofferdam where practicable and where ground conditions allow these methods to be adopted. In the piling methods, the contractor needs to give consideration to the proximity of sensitive receptors including Bridge house, Camelford House and Vauxhall Cross

c. compaction of material on site will be undertaken using machinery generating the lowest practicable vibration levels which still enables the required level of compaction to be completed. Specifically the use of large vibratory rollers will only be used in locations where vibration levels can be controlled to less than the impact criteria.

Operation

9.2.11 A ventilation structure would be constructed to contain filter equipment and to house the ventilation columns. The plant contained within electrical and control kiosks would have the potential to create noise impacts, and these are considered in the assessment.

9.2.12 During tunnel filling events water would descend via a vortex structure through the drop shaft to the connection tunnel below. The potential for noise generated by this movement of water through the shaft has been assessed.

Environmental design measures

9.2.13 The operational plant associated with the surface structures would incorporate environmental design measures to control noise emission to the nearest noise sensitive receptors to acceptable noise limits. These limits are as defined by the Local Authority in which the receptor lies. At Albert Embankment Foreshore, receptors within the London Borough (LB) of Lambeth have been considered, as well as receptors on the opposite bank of the Thames which lie within the City of Westminster (see paras. 9.3.16 and 9.3.17). The environmental design measures have considered the following noise sources:

a. hydraulic plant for penstock operation (pumps, motors)

b. uninterruptible power supply (UPS) plant.

9.2.14 In considering the noise from the above items, the sound insulation of the housing for the equipment has been taken into consideration.

9.2.15 The design of the drop shaft would control the descent of water by channelling the flow around the internal face of a vortex drop tube within the drop shaft, rather than allowing the water to free fall. The vortex design allows large volumes of water to descend with less noise generation than a falling cascade design.

9.3 Assessment methodology

Engagement

9.3.1 Volume 2 Environmental assessment methodology documents the overall engagement which has been undertaken in preparing the ES. Specific comments relevant to this site for the assessment of noise and vibration are presented here.

9.3.2 LB of Lambeth was consulted on the survey methodology and monitoring locations, and limits for plant noise from the operation of the site. A response was not received from LB of Lambeth and as such monitoring locations and operational limits for plant noise were determined according to the general methodology outlined in Volume 2 (see para. 9.3.16).

9.3.3 Westminster City Council was also consulted regarding limits for plant noise from the operation of the site and these were agreed with the council (see para. 9.3.17).

9.3.4 Specific comments relevant to this site for the assessment of noise and vibration are presented in Vol 16 Table 9.3.1. No other site specific noise and vibration consultation responses have been received from stakeholders at scoping or other consultation stages.

Vol 16 Table 9.3.1 Noise and vibration – consultation comments

Organisation	Comment	Response
English Heritage phase two consultation response (February 2012)	Vauxhall Bridge not identified as a receptor for vibration	Vauxhall Bridge is not identified as a receptor as it falls outside the scope of the assessment (see Volume 2). The construction at Albert Embankment Foreshore would be managed in accordance with the *CoCP* Parts A and B to ensure effects on Vauxhall Bridge are avoided.

Baseline

9.3.5 The baseline methodology follows the methodology provided in Vol 2. There are no site specific variations for this site.

Construction

9.3.6 The assessment methodology for the construction phase follows that described in Volume 2. The only variation of relevance for the Albert Embankment Foreshore site relates to the presentation of the assessment of the two access options (see 9.2.3).

9.3.7 There are no site specific variations for undertaking the construction assessment of this site.

9.3.8 Section 9.5 details the likely significant effects arising from the construction at the Albert Embankment Foreshore. There are no other Thames Tideway Tunnel sites which could give rise to additional effects on noise and vibration within the assessment area for this site, therefore no other Thames Tideway Tunnel sites are considered in this assessment.

9.3.9 The construction noise and vibration assessment has considered the effects across the whole duration of the construction phase and the worst-case exposure levels are reported. The development case (with the Thames Tideway Tunnel project) has been assessed against the base case (without the Thames Tideway Tunnel project).

9.3.10 All the schemes outlined in the development schedule (Vol 16 Appendix N) are further from the works than the receptors considered in this assessment and therefore no additional receptors have been considered for the construction base case.

9.3.11 Of the schemes outlined in the development schedule (Vol 16 Appendix N), the Vauxhall Square development is considered relevant to the construction cumulative assessment as it is assumed to be under construction at the same time as the Thames Tideway Tunnel. All other schemes are assumed to be complete and operational by Site Year 1 of construction or are located outside of the assessment area and as such are not relevant to the cumulative assessment.

9.3.12 Traffic flows on construction traffic routes have been examined to determine if there are any routes where there is the potential for traffic noise changes of 1dB(A) or more. This is according to the flow, speed or composition change criteria specified in Volume 2. The results show that there are no traffic changes on the road network associated with this site which meet the relevant criteria. This is discussed further in the assessment section from para. 9.5.42.

9.3.13 The assessment of construction effects also considers the extent to which the effects on noise and vibration would be likely to be materially different should the programme for the Thames Tideway Tunnel project be delayed by approximately one year.

Construction assessment area

9.3.14 As described in Volume 2 the assessment area considers unscreened receptors up to a maximum of 300m from the site boundary based on professional judgement of the likelihood of significant effects. The assessment primarily concentrates on those receptors closest to the site which would generally be most affected, rather than those further away which would be well screened by intervening buildings. Effects at more distant receptors beyond those closest to the site have been considered where necessary by reference to the impacts determined at the primary receptors.

Operation

9.3.15 The operational phase assessment methodology follows the methodology provided in Volume 2. Site specific variations to this methodology are set out below.

9.3.16 For residential receptors no information was received from LB Lambeth specifying their requirements for the control of noise from fixed plant noise sources. Volume 2 refers to a proposed approach where guidance is not received from the local authority. This approach is that noise emissions from this type of source are designed to meet a rating level (as defined in BS4142 [British Standards Institution, 1997][1]) which is 5dB(A) below the typical background noise level over the operational period of the plant at 1m from the facade.

9.3.17 For this site at residential receptors, Westminster City Council requires that noise emissions from this type of source are designed to meet a rating level (as defined in BS4142 [British Standards Institution, 1997]) which is 10dB below the typical background noise level over the operational period of the plant at 1m from the facade of the nearest residential receptor.

9.3.18 The operational assessment year is taken to be Year 1 of operation.

9.3.19 Section 9.6 details the likely significant effects arising from the operation at the Albert Embankment Foreshore. There are no other Thames Tideway

Tunnel sites which could give rise to additional effects on noise and vibration within the assessment area for this site, therefore no other Thames Tideway Tunnel sites are considered in this assessment.

9.3.20 All the schemes outlined in the development schedule (Vol 16 Appendix N) are further from the works than the receptors considered in this assessment and therefore no additional receptors have been considered in the operational base case.

9.3.21 There are no schemes identified in Vol 16 Appendix N that are considered relevant for the operational cumulative assessment, because due to their use, none are expected to generate significant noise or vibration levels during their operation.

9.3.22 Based on the traffic flow, speed or composition change criteria specified in Volume 2, there are no routes where potential for operational traffic noise effects would occur.

9.3.23 The assessment of operational effects also considers the extent to which the effects on noise and vibration would be likely to be materially different should the programme for the Thames Tideway Tunnel project be delayed by approximately one year.

Operational assessment area

9.3.24 Operational effects are considered up to 300m from the site boundary, although the focus is on the closest receptors.

Assumptions and limitations

9.3.25 The generic assumptions and limitations associated with this assessment are presented in Volume 2. The site specific assumptions and limitations are presented in the following section.

Assumptions

9.3.26 The working hours assumed for the assessment are as described in para. 9.2.7.

Limitations

9.3.27 A response has not been received from LB Lambeth with regards to noise monitoring locations and the borough's limits for noise from operational plant. As discussed in para. 9.3.1 a general methodology for selecting monitoring locations and determining limits for operational noise (set out in Volume 2) has been applied and as such the assessment is considered robust

9.3.28 Camelford House has been contacted in order to establish the baseline internal noise conditions within the building, however this information was not available at the time of the assessment. However, the assessment has been carried out in accordance with the methodology in Vol 2 and as such the assessment is considered robust.

9.4 Baseline conditions

9.4.1 The following section sets out the baseline conditions for noise and vibration within and around the site. Future baseline conditions (base case) are also described.

Current baseline

9.4.2 The current baseline noise conditions are as described in the baseline survey. The specific details of this survey, such as the measurement times, locations measured, results and local conditions are described in Vol 16 Appendix G. Vol 16 Table 9.4.1 below shows the measured ambient noise levels for the day, evening and night-time periods.

Receptors

9.4.3 This section describes the setting and receptor characteristics of the site for the purposes of this assessment.

9.4.4 The closest noise and vibration sensitive receptors selected for the noise and vibration assessment are identified in Vol 16 Table 9.4.1 below (and shown in plan view in Vol 16 Figure 9.4.1 - see separate volume of figures). These were selected as they are representative of the range of noise climates where sensitive receivers are situated around the site. The approximate number of residential properties affected at each location (where known) is indicated in Vol 16 Table 9.4.2.

9.4.5 The nearest residence to the site is 1-146 Bridge House to the southeast of the site. Peninsula Heights to the north of the site has also been assessed. Both receptors are in the LB of Lambeth. On the north bank of the Thames are the residential developments on Milbank and Grosvenor Road which are within the City of Westminster. The non-residential noise sensitive receptors selected for assessment are Vauxhall Cross, Camelford House and Tintagel House which are office buildings on the south bank in the LB of Lambeth.

9.4.6 Beyond these closest receptors there are other non-residential locations, generally office buildings, which are screened from the site by intervening buildings and these have not been assessed.

Receptor sensitivity

9.4.7 The sensitivities of noise and vibration receptors have been determined using the methodology outlined in Vol 2 Section 9.4. The sensitivities of all assessed receptors are presented in Vol 16 Table 9.4.1 along with the measured average ambient noise levels at each corresponding survey location.

Vol 16 Table 9.4.1 Noise and vibration – sensitive receptors and noise levels

Ref	Receptor addresses	Sensitivity	Local authority	Measured average ambient noise level, day/evening/ night, dBL_{Aeq^*}	Noise survey location
AE1	Peninsula Heights (residential)	High	LB Lambeth	67/67/59	AEF02
AE2	151 Rivermill (residential)	High	Westminster City Council	66/65/60	AEF04
AE3	48-57 Milbank (residential)	High	Westminster City Council	66/65/60	AEF04
AE4	1-146 Bridge House (residential)	High	LB Lambeth	72/72/64	AEF02**
AE5	Camelford House (offices)	Medium	LB Lambeth	61/61/57	AEF01
AE6	Vauxhall Cross (offices)	Medium	LB Lambeth	67/67/59	AEF02
AE7	Tintagel House (offices)	Medium	LB Lambeth	61/61/57	AEF01

** Noise level includes correction for façade acoustic reflection unless receptor position is an open outdoor space (eg, park)*
***The measurement is undertaken in a screened location from the road, whereas the receptors have a greater view of the road and therefore the levels at this measurement location have been increased by +5dB to better represent the receptor locations.*

9.4.8 The baseline noise level is considered representative of the relevant receptor. Consideration has been given to the distance of the measurement location to the receptor, the orientation of the primarily affected façade and location of the controlling noise source(s).

9.4.9 The criteria for determining the significance of noise effects at residences from construction sources are partly dependent upon the existing ambient noise levels. From the ambient noise levels measured during the baseline survey, the assessment category and assessment noise threshold levels for the residential receptors near the Albert Embankment Foreshore site have been identified and are as shown in Vol 16 Table 9.5.2. As described in the assessment methodology, this follows the method as defined in Vol 2 Table 9.5.1.

9.4.10 The assessment of significance at non-residential receptors is made according to the construction noise level relative to the ambient noise level (see Vol 16 Table 9.5.2) using the impact criteria described in Vol 2 Section 9.5 (where appropriate) and other factors described in Volume 2.

Vol 16 Table 9.4.2 Noise – residential receptors and assessment categories

Ref	Noise sensitive receptor (No. of dwellings)	Ambient noise level, rounded to nearest 5dBL$_{Aeq}$* day/ evening/ night	Assessment category* day/evening/ night	Significance criterion threshold level**, day, dBL$_{Aeq\ 10hour}$/ evening dBL$_{Aeq\ 1hour}$/ night, dBL$_{Aeq\ 1hour}$
AE1	Peninsula Heights (40)	65/65/60	B/C**/C**	70/67/59
AE2	151 Rivermill (40)	65/65/60	B/C/C**	70/65/60
AE3	48-57 Milbank (9)	65/65/60	B/C/C**	70/65/60
AE4	1-146 Bridge House (146)	70/70/65	C/C**/C**	75/72/64

* *From 'ABC' method – BS5228:2009*[2]

***Where the ambient noise level is greater than category C levels the ambient noise level shall be used as the significance criterion threshold.*

Construction base case

9.4.11 The base case taking into account the schemes described in Section 9.3 would not change as there are no additional sensitive receptors indicated because other schemes are further from the works than the receptors considered in this assessment.

9.4.12 The noise levels, as measured during the baseline noise survey in 2011, are assumed for the base case. However, there is the potential for variations to occur in the ambient noise levels between 2011 and the base case year. If the noise levels were to vary, it is likely that they would increase compared to the measured data from 2011 (due to natural traffic growth and the potential for additional construction noise from adjacent developments). The estimated traffic increases for the construction base case in Site Year 1 are such that noise levels would be expected to increase by less than 1dB(A) from those measured in 2011. The assessment based on data from 2011 therefore presents a worst case assessment.

9.4.13 It is considered that there are no other circumstances at this location that would cause the baseline noise levels at the receptor locations to change significantly between 2011 and the first year of construction.

9.4.14 The only existing major vibration sources immediately alongside the Albert Embankment foreshore site is the London Underground Victoria line which just inside the southern extent of the worksite. It is considered that vibration levels are unlikely to change between the present time and the base case.

Operational base case

9.4.15 The base case taking into account the schemes described in Section 9.3 would not change as there are no additional sensitive receptors indicated because other schemes are further from the works than the receptors considered in this assessment.

9.4.16 The base case in Year 1 of operation has been estimated from traffic flow expectations for the Year 1 of the operational phase as a result of natural growth and new development in the vicinity. The estimated traffic increases for the operational base case in Year 1 of operation are such that noise levels would be expected to increase by less than 1dB(A) from those measured in 2011.

9.5 Construction effects assessment

Noise

9.5.1 The two access options presented in Section 3 have been assessed and the results presented below. The results of the assessment of Option A are presented first, followed by a discussion of the changes to the assessment if Option B was chosen.

9.5.2 The results of the assessment of construction noise are presented in Vol 16 Table 9.5.1 and Vol 16 Table 9.5.2. The tables show the range of predicted construction noise levels during the entire period of the works and a typical monthly construction noise level. The typical monthly level is the most frequently occurring monthly noise level during the works. The tables also show the total number of months across all construction stages that the noise level would be likely to exceed the impact criterion threshold level indicating potential significance. The final columns in the tables show the worst-case excess above the impact criterion together with the duration of the worst-case noise level. In cases when the impact criterion is exceeded (as marked by an asterisk in Vol 16 Table 9.5.1), further assessment of the likely noise ingress to the interior of the building has been carried out to more precisely estimate the resulting noise impact on the occupants. The noise ingress would depend on the degree of façade noise insulation of the particular buildings which is considered in further detail in these cases.

9.5.3 To illustrate the predicted variation in construction noise levels at each receptor position across the duration of the construction phase, Vol 16 Plates G.5 to G.11 in Vol 16 Appendix G show the estimated noise levels plotted month-by-month over the approximate three and a half year total duration of the construction phase. The appendix also lists the construction plant and operations assumed for the calculations. The predicted impacts and assessed effects at each representative receptor location are described below.

Impacts at residential receptors

9.5.4 The results for residential receptors are shown below.

Vol 16 Table 9.5.1 Noise – impacts at residential receptors (high sensitivity)

Ref/ receptor[a] (No. of noise sensitive properties)	ABC impact criterion threshold level (potential significance for residential), dBL_{Aeq}[b]	Range of construction noise levels, dBL_{Aeq}[c,d]	Typical[e] monthly construction noise levels, dBL_{Aeq}	Magnitude		
				Total duration above criterion for all works, months	Worst-case excess above criterion, dBL_{Aeq}[f] (*further assessment undertaken for excess above criterion)	Duration of worst-case excess above criterion, months
AE1 Peninsula Heights (40)	70	55 – 72 (day)	55	1	+2*	1
	67	50 – 67 (eve)	53	0	0	0
	59	53 – 59 (night)	53	0	0	0
AE2 151 Rivermill (40)	70	45 – 64 (day)	53	0	-6	0
	65	43 – 59 (eve)	46	0	-6	0
	60	46 – 52 (night)	46	0	-8	0
AE3 48-57 Milbank (9)	70	46 – 65 (day)	46	0	-5	0
	65	44 – 60 (eve)	47	0	-5	0
	60	47 – 54 (night)	47	0	-6	0
AE4 1-146 Bridge House (146)	75	48 – 72 (day)	48	0	-3	0
	72	37 – 53 (eve)	40	0	-19	0
	64	40 – 47 (night)	40	0	-17	0

[a] Floors subject to highest noise level assessed – not necessarily the highest floor level

[b] The potential significance threshold is based on the ambient noise level as defined in Volume 2

[c] Construction noise only, excludes ambient noise. Refer to Volume 2 Section 9.5

[d] Noise level includes correction for façade acoustic reflection

[e] Most frequently occurring monthly construction noise level during works

[f] Positive value indicates exceedance, negative value indicates noise below criterion

9.5.5 The option of accessing the site from between Camelford House and Tintagel House (Option B), rather than Lack's Dock (Option A) would not alter the worst-case construction noise levels and the total duration above the criterion presented in Vol 16 Table 9.5.1. As such the effects for this option are the same as those presented below.

Peninsula Heights (AE1)

9.5.6 Peninsula Heights is a fourteen storey residential building. The upper floors, from the second floor and above, would directly overlook the site, albeit at a distance of some 50m from the site boundary, and due to the height of the building would not be screened by the site hoardings. The predicted noise levels at these dwellings due to construction activities are shown in Vol 16 Table 9.5.1.

9.5.7 The typical daytime noise levels (most frequently occurring monthly level) is 55dBL_{Aeq}. The activity expected to cause the worst-case noise level of 72dBL_{Aeq} would be the construction of the cofferdam and shaft commencement works.

9.5.8 During the evening and night- time, the construction of the connection tunnel is expected to cause the worst-case noise levels of 67dBL_{Aeq} and 59dBL_{Aeq} respectively.

9.5.9 The construction noise levels are not estimated to exceed the ABC potential significance criteria for a residential receptor during the evening and night-time. However, the estimated daytime noise level is predicted to exceed the potential significance criteria for one month.

9.5.10 As a potentially significant daytime noise effect has been identified using the ABC criterion, noise levels within the rooms most exposed to the construction works have been estimated. This has been based on conservative assumptions regarding the noise transmission through the façade with the windows closed. The approach to estimating internal noise levels is described in the methodology in Volume 2. Thermal double glazing has been assumed for this receptor (based on the age of the property and external observations) and takes into account the glazed area of the façade and a typical reverberant characteristic for a domestic room.

9.5.11 The worst-case internal noise level during the day is estimated to be 33dBL_{Aeq} for one month with windows closed or approximately 54BL_{Aeq} if windows were opened on the most exposed façade. The noise level is below the BS 8233 internal guidance noise level[3] of 40dBL_{Aeq}, with windows closed, and the noise levels would not be excessive for speech communication if windows were partially open, this is assessed **not significant**.

9.5.12 Excluding other receptors assessed specifically, there are no other residential properties in the vicinity close enough to be subject to significant adverse effects.

151 Rivermill (AE2)

9.5.13 Rivermill is a nine storey residential building on the north side of the river opposite the proposed site. The majority of the building is screened from the worksite by Vauxhall Bridge, but the upper floors would have a partial view of the site, albeit at a distance of more than 200m from the site boundary. The predicted noise levels at these dwellings due to construction activities are shown in Vol 16 Table 9.5.1.

9.5.14 The typical daytime noise levels (most frequently occurring monthly level) is 53dBL_{Aeq}. The activity expected to cause the worst-case noise level of 64dBL_{Aeq} would be the construction of the cofferdam and shaft commencement works.

9.5.15 During the evening and night-time, the construction of the connection tunnel is expected to cause the worst-case noise levels of 59dBL$_{Aeq}$ and 52dBL$_{Aeq}$ respectively.

9.5.16 The construction noise levels are not estimated to exceed the potential significance criteria for a residential receptor. The effect is therefore **not significant.**

9.5.17 Excluding other receptors assessed specifically, there are no other residential properties in the vicinity close enough to be subject to significant adverse effects.

48-57 Milbank (AE3)

9.5.18 48-57 Millbank is a twelve storey residential building on the north side of the river. The upper floors, from the second floor above would have at least a partial view of the site from a distance of more than 200m from the site boundary. The predicted noise levels at these dwellings due to construction activities are shown in Vol 16 Table 9.5.1.

9.5.19 The typical daytime noise levels (most frequently occurring monthly level) is 46dBL$_{Aeq}$. The activity expected to cause the worst-case noise level of 65dBL$_{Aeq}$ would be the concurrent cofferdam piling and shaft commencement works.

9.5.20 During the evening and night-time, the construction of the connection tunnel is expected to cause the worst-case noise levels of 60dBL$_{Aeq}$ and 54dBL$_{Aeq}$ respectively.

9.5.21 The construction noise levels are not estimated to exceed the potential significance criteria for a residential receptor. The effect is therefore **not significant**.

9.5.22 Excluding other receptors assessed specifically, there are no other residential properties in the vicinity close enough to be subject to significant adverse effects.

1-146 Bridge House (AE4)

9.5.23 Bridge House is a thirteen storey residential building. All floors would have a view of the culvert works in the foreshore to the south of Vauxhall Bridge; however the majority of the remaining works would be screened by Vauxhall Bridge and other existing structures. At closest the worksite is a distance of approximately 30m, although the main shaft is located more than 200m from this building. The predicted noise levels at these dwellings due to construction activities are shown in Vol 16 Table 9.5.1.

9.5.24 The typical daytime noise levels (most frequently occurring monthly level) is 48dBL$_{Aeq}$. The activity expected to cause the worst-case noise level of 72dBL$_{Aeq}$ would be the cofferdam piling works and interception and culvert works.

9.5.25 During the evening and night-time, the construction of the main tunnel is expected to cause the worst-case noise levels of 53dBL$_{Aeq}$ and 47dBL$_{Aeq}$ respectively.

9.5.26 The construction noise levels are not estimated to exceed the potential significance criteria for a residential receptor. The effect is therefore **not significant**.

9.5.27 Excluding other receptors assessed specifically, there are no other residential properties in the vicinity close enough to be subject to significant adverse effects.

Impacts at non-residential receptors

9.5.28 The results for non-residential receptors are shown below.

Vol 16 Table 9.5.2 Noise – impacts at non-residential receptors

Ref/receptor	Receptor sensitivity[a]	Range of construction noise levels, dBL_{Aeq}[b,c,d]	Ambient baseline noise level, dBL_{Aeq}[d]	Typical[e] monthly construction noise levels, dBL_{Aeq}	Magnitude	
					Total duration above ambient for all works, months	Worst-case excess above ambient, dBL_{Aeq}
AE5 Camelford House	Medium	60 – 80 (day)	61	60	39	+19
AE6 Vauxhall Cross	Medium	63 – 78 (day)	67	63	25	+11
AE7 Tintagel House	Medium	60 – 77 (day)	61	60	35	+16

[a] *Assumed typical façade transmission loss and appropriate internal noise guidelines*

[b] *Floors subject to highest level assessed – not necessarily the highest floor level*

[c] *Construction noise only, excludes ambient noise. Refer to Volume 2*

[d] *Noise level includes correction for façade acoustic reflection unless receptor position is an open outdoor space (eg park)*

[e] *Most frequently occurring monthly construction noise level during works*

Camelford House (AE5)

9.5.29 Camelford House is a sixteen storey office building which is a ‘T’ shape with the most western extent on the site boundary. Certain areas would have an unscreened view of the worksite and others would be screened by the site hoarding or orientated away from some of the works.

9.5.30 The typical daytime noise level (most frequently occurring monthly level) is 60dB(A). The worst-case daytime noise level shown in Vol 16 Table 9.5.2 would occur during the construction of the shaft by diaphragm walling.

9.5.31 The worst-case daytime noise level of 80dBL_{Aeq} is greater than the current ambient noise level for the respective period. The increase in average noise levels inside the building could exceed guideline noise levels for general office use based on typical noise insulation designed for a façade of this type.

9.5.32 Noise at this receptor is considered to be **significant**.

Vauxhall Cross (BB6)

9.5.33 Vauxhall Cross is a ten storey office building located approximately the site boundary. Certain areas would have an unscreened view of the worksite and others would be screened by the site hoarding or orientated away from some of the works.

9.5.34 The typical daytime noise level (most frequently occurring monthly level) is 63dB(A). The worst-case daytime noise level shown in Vol 16 Table 9.5.2 would occur during the construction of the shaft by diaphragm walling.

9.5.35 The worst-case daytime noise level of 78dBL_{Aeq} is greater than the current ambient noise level for the respective period. The increase in average noise levels inside the building could exceed guideline noise levels for general office use based on typical noise insulation designed for a façade of this type.

9.5.36 Noise at this receptor is considered to be **significant**.

Tintagel House (AE7)

9.5.37 Tintagel House is an eleven storey office building which is located approximately 10m from the site boundary. The majority of floors would have at least a partial view of the worksite.

9.5.38 The typical daytime noise level (most frequently occurring monthly level) is 60dB(A). The worst-case daytime noise level shown in Vol 16 Table 9.5.2 would occur during the construction of the shaft by diaphragm walling.

9.5.39 The worst-case daytime noise level of 77dBL_{Aeq} is greater than the current ambient noise level for the respective period. The increase in average noise levels inside the building could exceed guideline noise levels for general office use based on typical noise insulation designed for a façade of this type.

9.5.40 Noise at this receptor is considered to be **significant**.

Assessment of access option (Option B)

9.5.41 The option of the construction site access being between Camelford House and Tintagel House (Option B), rather than Lack's Dock (Option A) would not alter the worst-case construction noise levels and the total duration above the criterion presented in Vol 16 Table 9.5.1. As such the effects for this option are the same as those presented above.

Road-based construction traffic

9.5.42 The location of the site adjacent to Albert Embankment provides direct access to the major road network through London. The construction programme would result in varying traffic generation over a period of four years. During the peak construction period the traffic generation is forecast to average 23 heavy vehicles (HGV) per day, equivalent to 46 movements per day.

9.5.43 The major road links adjacent to and leading to the site are Lambeth Road, Vauxhall Bridge, Bridgefoot, Kennington Lane, Harleyford Road, South Lambeth Road, Parry Street, Nine Elms Lane and Wandsworth Road. Vehicles would not use other local roads such as Tyres Street and Glasshouse Walk.

9.5.44 A flow change of about 25% is required to cause a change in noise level of 1dB and by 100% to cause a change of 3dB, which is considered to be the minimum change perceptible to the human ear. Additionally, a change in heavy vehicles (HGV) proportion of 5% is also considered to cause a change in noise level of 1dB.

9.5.45 The traffic modelling shows that the 18hr flow on the section of Albert Embankment which is adjacent to the site is currently over 30,000 vehicles per day (vpd), with average speeds of 30 mph (48 kph) and 7.7 % Heavy Vehicles (HGVs). The total number of HGVs is therefore currently over 2,300 per day.

9.5.46 Wandsworth Road, south of Albert Embankment has the highest 18hr flow, with over 35,000 vpd with 10.4% HGVs. The 18hr flows on other roads are varied, with the majority of flows ranging from close to 35,000 vpd to values which are approximately a third of this flow. The majority of these roads have a higher percentage of HGVs than Wandsworth Road.

9.5.47 The modelling of construction traffic on these links shows that the highest percentage increase in total flow due to construction traffic would occur on the section of Albert Embankment to the Southeast of the site. The current flow is 4,570 vpd. The average daily number of construction HGVs on this link during the peak month of construction is 23 and the average daily number of office/operational light vehicles on surrounding links is predicted to be up to 36, with the number of cars and light vehicles consistent across the construction period. This represents a percentage increase in flow of less than 0.5%.

9.5.48 Additionally, the modelling of the construction traffic on these links shows that the highest increase in HGV composition would also occur on this section of Albert Embankment. The average daily number of construction HGVs on this link during the peak month of construction is 23, which represents an increase in HGV composition of less than 0.5%.

9.5.49 Therefore, the percentage flow change and change in HGV percentage do not meet the criteria for causing even a 1dB change in noise level. The additional numbers of HGVs would not cause any change to the traffic noise levels and hence effects are assessed as **not significant**.

Assessment of access option (Option B)

9.5.50 The option of accessing the site from between Camelford House and Tintagel House (Option B), rather than Lack's Dock (Option A) would not alter the findings of the road based construction traffic assessment above as the route leading to the site would be the same.

River-based construction traffic

9.5.51 The use of barges for the transport of materials to and from the site could result in noise impacts at nearby receptors.

9.5.52 The movement of these barges would be at appropriate stages in the tide. In between times, and during standard working hours, the moored barges would be unloaded or loaded. Noise measurements for such activity have been reported in other studies[3]. The engine noise from movement of the barges, on the river Thames is limited to 75dB(A) at 25m[4].

9.5.53 At peak use, it is assumed that four barges (eight movements would be used operating with the tide. Outside of the peak use the number of barges (pulled by tugs) is considerably reduced. Each movement (delivery and removal) would be approximately 20 minutes in duration.

9.5.54 The operation, loading and removal of the river barges which takes place within the site boundary has been considered in the construction noise assessment in paras 9.5.1 to 9.5.41 above.

9.5.55 The operation of the barges on the river outside of the site boundary have been assessed in relation to the nearest residential receptors, Peninsula Heights to the east and Bridge House to the west.

9.5.56 At Peninsula Heights the barges would operate at a minimum distance of 50m. At this distance the predicted noise from this activity during the day/evening (7am to 11pm) and night-time (11pm to 7am) periods would be 58dB L_{Aeq}. The survey indicates the day/evening time and night-time noise levels at this location are 67dB L_{Aeq} and 59dBL_{Aeq} respectively, as identified in Vol 16, Appendix G Table G.8. A change of less than 3dB is predicted and therefore the noise from river-based construction traffic is considered to be **not significant**.

9.5.57 At Bridge House the tugs would operate at a minimum distance of 75m. At this distance the predicted noise from this activity during the day/evening (7am to 11pm) and night-time (11pm to 7am) periods would be 5dB L_{Aeq}. The survey indicates the day/evening time and night-time noise levels at this location are 72dB L_{Aeq} and 64dBL_{Aeq} respectively, as identified in Vol 16 Appendix G Table G.8. A change of less than 3dB is predicted and therefore the noise from river based construction traffic is considered to be **not significant**.

Assessment of access option (Option B)

9.5.58 The option of accessing the site from between Camelford House and Tintagel House (Option B), rather than Lack's Dock (Option A) would not alter the findings of the river based construction traffic assessment above as the number of barges required would not change.

Vibration

9.5.59 The assessment of construction vibration considers events which have the potential to cause human disturbance, or damage to buildings and structures. The assessments of human disturbance and effects on building structures are carried out separately using different parameters.

9.5.60 The assessment has been conducted using the methodology defined in Volume 2.

9.5.61 The assessment of human disturbance due to construction vibration impacts at neighbouring receptors has been assessed using the predicted estimated Vibration Dose Value (eVDV). The results from the assessment are presented in Vol 16 Table 9.5.3.

Vol 16 Table 9.5.3 Vibration – impact and magnitude of human response to vibration impacts

Ref	Receptor	Impact (highest predicted eVDV across all activities, $m/s^{1.75}$)*	Value/ sensitivity	Magnitude
AE1	Peninsula Heights	<0.4	High	Low probability of adverse comment – No impact
AE2	151 Rivermill	<0.1	High	Below low probability of adverse comment – No impact
AE3	48-57 Milbank	<0.1	High	Below low probability of adverse comment – No impact
AE4	1-146 Bridge House	<1.2	High	Adverse comment probable - Impact
AE5	Camelford House	<3.0	Medium	Adverse comment probable - Impact
AE6	Vauxhall Cross	<3.0	Medium	Adverse comment probable - Impact
AE7	Tintagel House	<1.2	Medium	Adverse comment possible – Impact

**Most affected floor*

9.5.62 The predicted eVDV levels at Peninsula Heights, Rivermill and Milbank residential receptors fall within or below the ‘Low probability of adverse comment’ band, as described in Vol 2 and therefore **no significant effects** are anticipated at these locations.

9.5.63 The predicted eVDV levels at Bridge House residential receptor fall within the ‘Adverse comment probable’ band, as described in Volume 2 and therefore a **significant effect** is identified at this location.

9.5.64 The predicted eVDV level at Tintagel House falls within the ‘Adverse comment possible’ band, as described in Volume 2 for offices. These levels occur only during the closest cofferdam piling which occurs for a short duration, less than 1 month and this is considered to be **not significant**.

9.5.65 The predicted eVDV level at Vauxhall Cross and Camelford House fall within the 'Adverse comment probable' band, as described in Volume 2 for offices. These levels occur during the closest cofferdam piling compaction, and the shaft piling required at the start of the shaft construction. Whilst these activities are of a reasonably short duration, (less than two months) the level of vibration is considered to be **significant** at these receptors.

9.5.66 The *CoCP Part A* seeks to ensure that piling methods which limit noise and vibration are selected where possible (*CoCP Part A* para. 6.4.3d). If ground conditions at the Albert Embankment Foreshore site are such that these methods could be implemented, effects would not be significant. However as the specific ground conditions encountered will not be known until piling is underway, it cannot be guaranteed that these measures can be implemented. Therefore, in the worst-case, **significant** effects at Bridge House, Vauxhall Cross and Camelford House (as identified above) would arise from piling.

9.5.67 The assessment of potential construction vibration effects at adjacent buildings/structures has been assessed using the predicted Peak Particle Velocity (PPV), according to the criteria given in Volume 2. The results of the assessment of construction vibration are presented in Vol 16 Table 9.5.4.

Vol 16 Table 9.5.4 Vibration – building vibration impacts and their magnitudes

Ref	Receptor	Impact (highest predicted PPV across all activities, mm/s)	Value/ sensitivity	Magnitude*
AE1	Peninsula Heights	<0.5	High	Below threshold of potential cosmetic damage – No impact
AE2	151 Rivermill	<0.1	High	Below threshold of potential cosmetic damage – No impact
AE3	48-57 Milbank	<0.1	High	Below threshold of potential cosmetic damage – No impact
AE4	1-146 Bridge House	<1.0	High	Below threshold of potential cosmetic damage – No impact
AE5	Camelford House	<3.0	Medium	Below threshold of potential cosmetic

Ref	Receptor	Impact (highest predicted PPV across all activities, mm/s)	Value/ sensitivity	Magnitude*
				damage – No impact
AE6	Vauxhall Cross	<3.0	Medium	Below threshold of potential cosmetic damage – No impact
AE7	Tintagel House	<1.5	Medium	Below threshold of potential cosmetic damage – No impact

* *Most affected floor*

9.5.68 The vibration levels reported here are well below the levels likely to cause cosmetic building damage according to the criteria described in Volume 2.

9.5.69 Vibration effects are significant at 1-16 Bridge House, Camelford House and Vauxhall Cross. The duration of these impacts is likely to be short, lasting at most during the piling works associated with the cofferdam and shaft construction.

Assessment of access option (Option B)

9.5.70 The option of accessing the site from between Camelford House and Tintagel House (Option B), rather than Lack's Dock (Option A) would not alter the findings of the construction vibration assessment above.

Sensitivity test for programme delay

9.5.71 For the assessment of noise and vibration effects during construction, a delay to the Thames Tideway Tunnel project of approximately one year would not be likely to materially change the assessment findings reported above for the existing and proposed receptors. Based on the development schedule (Vol 16 Appendix N), there would be no new receptors, within the assessment area, requiring assessment as a result of a one year delay.

9.6 Operational effects assessment

Impacts from potential noise and vibration sources

9.6.1 The following section describes the potential noise and vibration effects from various sources identified for assessment.

Noise from operational plant at above ground structure

9.6.2 The prediction method and assumptions are described in Volume 2.

9.6.3 A passive filter system is to be installed at Albert Embankment Foreshore and therefore there is no requirement to install active ventilation equipment at this location.

9.6.4 The appropriate emission limits are shown below in Vol 16 Table 9.6.1, based on local authority requirements to ensure that no adverse effects would occur. As there is no active ventilation plant for the drop shaft to generate noise at this site, these limits would only apply to any minor plant equipment. If cooling fans for the kiosks are required this equipment would be controlled to meet the criteria in Vol 16 Table 9.6.1 although it such equipment would be expected to have a relatively low noise emission (approximately 45dB(A) at 3m).

9.6.5 There would be a pump to maintain hydraulic pressure in the hydraulic pipe-work and rams for the penstocks although the noise emission would be short and infrequent. It is expected that this would produce a whirring noise about once a week with a duration of approximately 30 seconds to 2 minutes depending on the size of the penstock and hydraulic system. The plant would be operated for testing purposes once every three months. The power pack, pump and motor would be located within the kiosks and would be shielded with an acoustic surround if necessary to meet the requirements in Vol 16 Table 9.6.1 shows, for each receptor, that the estimated plant noise level is below the relevant local authority limit (either LB Lambeth or Westminster City Council), or is less than ambient levels for residential and non-residential receptors respectively.

Vol 16 Table 9.6.1 Noise – operational airborne noise impacts

Ref	Receptor	Lowest baseline noise level	Impact	Value/ sensitivity	Magnitude
AE1	Peninsula Heights	48dB$L_{A90,\ 15\ minutes}$	Plant noise emission rating level at receptor less than 43dB$L_{Ar,Tr}$	High	Plant noise level below local authority limit*,– no adverse impact
AE2	151 Rivermill	54dB$L_{Aeq,\ 15\ minutes}$	Plant noise emission rating level at receptor less than 44dB$L_{Ar,Tr}$	High	Plant noise level below local authority limit*,– no adverse impact
AE3	48-57 Milbank	54dB$L_{Aeq,\ 15\ minutes}$	Plant noise emission rating level at receptor less than 44dB$L_{Ar,Tr}$	High	Plant noise level below local authority limit*,– no adverse

Ref	Receptor	Lowest baseline noise level	Impact	Value/ sensitivity	Magnitude
					impact
AE4	1-146 Bridge House	48dB$L_{A90, 15 mins}$	Plant noise emission rating level at receptor less than 43dB$L_{Ar,Tr}$	High	Plant noise level below local authority limit*,– no adverse impact
AE5	Camelford House	61dB$L_{Aeq, 1 hour}$	Plant noise emission level at receptor less than 61dBL_{Aeq}	Medium	Plant noise level below ambient evening level – no adverse impact
AE6	SIS HQ Building	67dB$L_{Aeq, 1 hour}$	Plant noise emission level at receptor less than 67dBL_{Aeq}	Medium	Plant noise level below ambient evening level – no adverse impact
AE7	Tintagel House	61dB$L_{Aeq, 1 hour}$	Plant noise emission level at receptor less than 61dBL_{Aeq}	Medium	Plant noise level below ambient evening level – no adverse impact

**Limit referred to is that identified for the Local Authority in which the receptor is located (see para.9.3.16).*

9.6.6 The results given above in Vol 16 Table 9.6.1 show that there are no adverse impacts and the effects of plant noise at these emission levels is assessed as not significant. In the case of the residential receptor, this is based on compliance with the local authority requirements to prevent disturbance. For the non-residential receptors the noise levels are below ambient noise levels and therefore considered to result in **no significant effects**.

Noise and vibration from tunnel filling

9.6.7 Measurements taken during storm and non-storm events at operational drop structures in the United States, equivalent to those being considered for the Thames Tideway Tunnel, have been used to inform the assessment of noise and vibration during tunnel filling events. These studies (Jain, SC and Kennedy, JF., 1983)[4] are described in Volume 2. The highest noise level measured on a mesh grille directly over a similar drop shaft, during this study, was 61dBL_{Aeq} during a severe storm event.

9.6.8 These events are not typical and only occur during severe rain storms. At Albert Embankment Foreshore, the drop shaft would be enclosed and any noise at the surface would be attenuated by the structure or the carbon filters and vent building. At the surface the noise level would be approximately 46dB$L_{Aeq,}$ which is less than the prevailing ambient noise level at this site

9.6.9 The highest peak particle velocity (PPV) measured directly at the existing drop shaft sites used in the case study as described in Volume 2 was 0.034mm/s. These measured PPV values are well below the levels for vibration to be just perceptible, according to the criterion given in Volume 2. Similarly, the levels are well below the transient and continuous vibration guideline criterion for building damage.

9.6.10 The noise and vibration from tunnel filling events would occur only occasionally during heavy rainfall events and, in any case, is predicted to be not perceptible/less than the ambient noise level at the receptors. Therefore this is assessed as **not significant**.

Operational maintenance

9.6.11 As part of the operation of the tunnel, there would need to be routine but infrequent maintenance carried out at the site. Two cranes would be required for ten yearly shaft inspections. This would be carried out during normal working hours, using equipment which is likely to increase ambient noise levels. Given the infrequency of this operation, it is considered that a significant noise effect would not occur.

9.6.12 Routine inspections, lasting approximately half a day, would occur every three to six months and would not require heavy plant. As this would be carried out during the daytime with minimal noisy equipment operating over short periods of time, it is considered that further assessment of noise generated by this activity is not required.

9.6.13 As no impacts have been identified from the operation of the site, this is assessed as **not significant**.

Noise from operational traffic

9.6.14 Additional traffic associated with operation of the site would be limited to vehicles used by maintenance and inspection workers. This is likely to be a number of light commercial vehicles used during routine inspection visits every three to six months and shaft inspections approximately every ten years.

9.6.15 As a proportion of the existing traffic on the road network these vehicles would not contribute to the traffic noise level and the noise effects of these movements are assessed as **not significant**.

Sensitivity test for programme delay

9.6.16 For the assessment of noise and vibration effects during operation, a delay to the Thames Tideway Tunnel project of approximately one year would not be likely to materially change the assessment findings reported above for the existing and proposed receptors as the operational effects of the Thames Tideway Tunnel are considered to be not significant. Based on the development schedule (Vol 16 Appendix N), there would be no new receptors, within the assessment area, requiring assessment as a result of a one year delay.

9.7 Cumulative effects assessment

Construction effects

9.7.1 Of the schemes outlined in the development schedule (Vol 16 Appendix N), the Vauxhall Square Cap Gemini development is considered relevant to the construction assessment base case as it is assumed to be under construction at the same time as the Thames Tideway Tunnel. Owing to the distance of the Vauxhall Square development and the high existing noise levels, cumulative effects from this development and the works at Albert embankment are unlikely to cause cumulative effects. This would also be the case if the programme for the Thames Tideway Tunnel project was delayed by approximately one year.

Assessment of access option (Option B)

9.7.2 The assessment above would remain the same under access Option B.

Operational effects

9.7.3 None of the schemes described in Section 9.3, are considered relevant to the operational cumulative assessment at Albert Embankment Foreshore as due to their use they are not expected to generate significant noise or vibration levels during their operation. As such, no cumulative operational noise or vibration effects are identified. This would also be the case if the programme for the Thames Tideway Tunnel project was delayed by approximately one year.

9.8 Mitigation and compensation

Construction

9.8.1 The above assessment has concluded that there are significant adverse noise effects during the construction phase at Camelford House, Tintagel House and Vauxhall Cross, however no further practicable on-site noise mitigation can be adopted in addition to those measures identified in the *CoCP*.

9.8.2 The noise levels predicted at these properties are rated as significant using the extended ABC and qualitative method (as discussed in Section 9.5 and Volume 2) however the levels would not exceed the thresholds given in the *Thames Tideway Tunnel noise insulation and temporary re-housing policy* (see Schedule 2 of the *Statement of Reasons*, which accompanies this application) and as such these properties would not be eligible for noise insulation under this policy.

9.8.3 The owners of Camelford House, Tintagel House and Vauxhall Cross may be eligible to apply for compensation through the *Thames Tideway Tunnel compensation programme* (see Schedule 2 of the *Statement of Reasons*, which accompanies this application) which has been established to address claims of exceptional hardship or disturbance. The measures set out in the programme are not considered to be mitigation as there is no guarantee that the property in question would be eligible for compensation or that the compensation would be accepted by the affected party. Therefore residual effects reported in the ES for this receptor do not take the offsetting effect of the compensation programme into account

9.8.4 The above assessment has concluded that there are significant adverse vibration effects during the construction phase at 1-146 Bridge House, Camelford House and Vauxhall Cross. The use of low vibration piling methods where practicable is specified in *CoCP Part A. A*s discussed in para. 9.5.66, it cannot be guaranteed that these measures can be implemented and as such significant adverse vibration effects are predicted. There are no further mitigation measures that can be adopted beyond these measures set out in the *CoCP*. The residents/owners of 1-146 Bridge House, Camelford House and Vauxhall Cross may be eligible to apply for compensation through the *Thames Tideway Tunnel compensation programme* (see Schedule 2 of the *Statement of Reasons,* which accompanies the application) which has been established to address claims of exceptional hardship or disturbance.

9.8.5 The measures set out in the programme are not considered to be mitigation as there is no guarantee that the property in question would be eligible for compensation or that the compensation would be accepted by the affected party. Therefore residual effects reported in the *Environmental Statement* for this receptor do not take the offsetting effect of the compensation programme into account.

Operation

9.8.6 No significant effects as a result of the operation of the site have been identified; hence no additional noise mitigation is required at this location.

Monitoring

9.8.7 Monitoring of construction noise would be carried out as described in the *CoCP*. It is not anticipated that there would be any need for monitoring of operational noise.

9.9 Residual effects assessment

Construction effects

Noise

9.9.1 As discussed at para. 9.8.2 the noise levels at Camelford House, Tintagel House and Vauxhall Cross are rated as significant using the extended ABC and qualitative method (as discussed in Section 9.5 and Volume 2) but do not exceed the thresholds for noise insulation set out in the *Thames Tideway Tunnel noise insulation and temporary re-housing policy*. The owners of Camelford House, Tintagel House and Vauxhall Cross may, however, be eligible to apply for compensation under the *Thames Tideway Tunnel project compensation programme.* For the purpose of the assessment the residual effects reported in the ES do not take the offsetting effects of the compensation programme into account and therefore the construction noise effects would remain as presented in Section 9.5.

9.9.2 The use of low vibration piling methods where practicable would be used, however, it cannot be guaranteed that these measures could be implemented. Hence, the construction vibration effects would remain as presented in Section 9.5.

Vibration

9.9.3 The residents/owners of 1-146 Bridge House, Camelford House and Vauxhall Cross may also be eligible for compensation for vibration effects under the *Thames Tideway Tunnel project compensation programme*. In addition, the use of low vibration piling methods where practicable would be used. However, it cannot be guaranteed that these measures could be implemented. Hence, the construction vibration effects would remain as presented in Section 9.5.

Operational effects

9.9.4 As no mitigation measures are proposed, the residual operational effects remain as presented in Section 9.6.

9.10 Assessment summary

9.10.1 This topic assessment has considered both access Options A and B and given that there are not anticipated to be any differences, the assessment summary table reflects both options.

Vol 16 Table 9.10.1 Noise – summary of construction assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Surface construction noise				
AE1 - Peninsula Heights	Noise	Not significant	None	Not significant
AE2 - 151 Rivermill	Noise	Not significant	None	Not significant
AE3 - 48-57 Milbank	Noise	Not significant	None	Not significant
AE4 - 1-146 Bridge House	Noise	Not significant	None	Not significant
AE5 - Camelford House	Noise	Significant	No further on site mitigation practicable	Significant, however properties may be eligible for compensation (see para. 9.8.3)
AE6 - Vauxhall Cross	Noise	Significant	No further on site mitigation practicable	Significant, however properties may be eligible for compensation (see para. 9.8.3)
AE7 - Tintagel House	Noise	Significant	No further on site mitigation practicable	Significant, however properties may be eligible for compensation (see

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
				para. 9.8.3)
Road-based construction traffic				
Residential and non-residential properties adjacent to the proposed vehicle route	Noise	Not significant	None	Not significant
River-based construction traffic				
AE1 - Peninsula Heights	Noise	Not significant	None	Not significant
AE4 - 1-146 Bridge House	Noise	Not significant	None	Not significant

Vol 16 Table 9.10.2 Vibration – summary of construction assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect	Comments
AE1 - Peninsula Heights	Vibration	Not significant	None	Not significant	
AE2 - 151 Rivermill	Vibration	Not significant	None	Not significant	
AE3 - 48-57 Milbank	Vibration	Not significant	None	Not significant	
AE4 - 1-146 Bridge House	Vibration	Significant	No further on site piling mitigation practicable	Significant, however properties may be eligible for compensation (see para. 9.8.4)	As discussed in para. 9.5.66, successful implementation of low vibration piling as set out in the *CoCP* would reduce the effect to not

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect	Comments
					significant.
AE5 - Camelford House	Vibration	Significant	No further on site piling mitigation practicable	Significant, however properties may be eligible for compensation (see para. 9.8.4)	As discussed in para. 9.5.66, successful implementation of low vibration piling as set out in the *CoCP* would reduce the effect to not significant.
AE6 - Vauxhall Cross	Vibration	Significant	No further on site piling mitigation practicable	Significant, however properties may be eligible for compensation (see para. 9.8.4)	As discussed in para. 9.5.66, successful implementation of low vibration piling as set out in the *CoCP* would reduce the effect to not significant.
AE7 - Tintagel House	Vibration	Not significant	None	Not significant	

Vol 16 Table 9.10.3 Noise – summary of operational assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
AE1 - Peninsula Heights	Noise	Not significant	None	Not significant
AE2 - 151 Rivermill	Noise	Not significant	None	Not significant
AE3 - 48-57 Milbank	Noise	Not significant	None	Not significant
AE4 - 1-146 Bridge House	Noise	Not significant	None	Not significant
AE5 - Camelford House	Noise	Not significant	None	Not significant
AE6 - Vauxhall Cross	Noise	Not significant	None	Not significant
AE7 - Tintagel House	Noise	Not significant	None	Not significant

Vol 16 Table 9.10.4 Vibration – summary of operational assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
AE1 - Peninsula Heights	Vibration	Not significant	None	Not significant
AE2 - 151 Rivermill	Vibration	Not significant	None	Not significant
AE3 - 48-57 Milbank	Vibration	Not significant	None	Not significant
AE4 - 1-146 Bridge House	Vibration	Not significant	None	Not significant
AE5 - Camelford House	Vibration	Not significant	None	Not significant
AE6 - Vauxhall Cross	Vibration	Not significant	None	Not significant
AE7 - Tintagel House	Vibration	Not significant	None	Not significant

References

[1] British Standards Institution, *BS 4142 Method for rating industrial noise affecting mixed residential and industrial areas* (1997).

[2] British Standards Institution, *BS 5228 Code of Practice for Noise and Vibration Control on Open Construction Sites* (2009)

[3] British Standards Institution, *BS 8233 Code of Practice for Sound insulation and noise reduction for buildings* (1999)

[4] Jain, SC and Kennedy, JF. *Vortex-Flow Drop Structures for the Milwaukee Metropolitan Sewerage District Inline Storage System*. Iowa Institute of Hydraulic Research. IIHR Report No 264 (Jul 1983).

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.16**

Volume 16: Albert Embankment Foreshore site assessment

Section 10: Socio-economics

APFP Regulations 2009: Regulation **5(2)(a)**

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Environmental Statement

Volume 16: Albert Embankment Foreshore site assessment

Section 10: Socio-economics

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10 Socio-economics

10.1 Introduction

10.1.1 This section presents the findings of the assessment of the likely significant socio-economic effects of the proposed development at the Albert Embankment Foreshore site. At this site effects during construction are considered on users of the Thames Path National Trail and Right of Way (Thames Path), the users of Lacks Dock slipway (Duck Tours) and nearby residents. During the operational phase, effects are considered on users of the Thames Path and the associated future public amenity space that would be created as a result of the project.

10.1.2 The likely significant project-wide socio-economic effects, including employment generation, stimulation of the freight-by-water industry, and leisure, recreation and health related effects on users of the River Thames, are described in Volume 3 Project-wide effects assessment.

10.1.3 The assessment of socio-economics presented in this section has considered the requirements of the National Policy Statement for Waste Water Sections 4.8 (land use) and 4.15 (socio-economic) (Defra, 2012)[1]. Further details of these requirements can be found in Volume 2 Environmental assessment methodology Section 10.3.

10.1.4 Plans of the proposed development as well as figures included in the assessment for this site are contained in a separate volume (Volume 16 Albert Embankment Foreshore Figures).

10.1.5 This assessment has drawn on the findings of the air quality and odour, noise and vibration and townscape and visual assessments (Sections 4, 9 and 11 respectively within this volume).

10.2 Proposed development relevant to socio-economics

10.2.1 The proposed development is described in Section 3 of this volume. The elements of the proposed development relevant to socio-economics are set out below.

Construction

10.2.2 There are two options for construction at this site. The first is for a construction access route via Lacks Dock (Option A) and the second is for a temporary construction access route between Camelford House and Tintagel House, with minimal access via Lacks Dock (Option B). In both instances, the construction site would extend from the south side of Vauxhall Bridge in front of Bridge House (a residential block within the St George Wharf complex) to the north side of the bridge as far as Tintagel House.

10.2.3 If Option A were to proceed, an access / haul route would be created along the entrance way to Lacks Dock, a slipway that is currently used by

London Duck Tours (or Duck Tours - a sightseeing tour company which uses amphibious vehicles). The existing security kiosk and security barrier would be temporarily relocated during the construction phase, to the northern side of the slipway entrance, and access through the site to the foreshore would be maintained for the Duck Tour vehicles. The security kiosk and barrier would be reinstated in their original position after construction is complete.

10.2.4 If Option B were to proceed, an access / haul route would be created via the existing private road between Camelford House and Tintagel House. The existing road currently provides access to a private underground car park at Camelford House. The existing security barrier would be temporarily removed during the construction phase. Under this option, construction vehicles would occasionally need to be routed along Lacks Dock during the construction phase but only during the delivery of large items of plant (for example, cranes or excavators).

10.2.5 The Thames Path National Trail and Public Right of Way (Thames Path) between Albert Embankment Gardens and St George Wharf would be temporarily diverted for the duration of the construction period.

10.2.6 Works at the site are expected to last approximately three and a half years. For further details on construction working hours, see Section 3.3 of this volume.

10.2.7 Construction related activities, including traffic and lorry movements, could result in amenity effects (caused by air quality impacts, construction dust, noise, vibration, and visual impacts) being experienced by a range of sensitive socio-economic receptors in proximity to the proposed activities (refer to Volume 2 Environmental assessment methodology for further information on the amenity assessment methodology).

Direct employment creation on site

10.2.8 Construction is expected to require a maximum workforce of approximately 65 workers at any one time. The number and type of workers is shown in Vol 16 Table 10.2.1.

Vol 16 Table 10.2.1 Socio-economics – construction worker numbers

Contractor		Client
Staff*	**Labour****	**Staff**
08:00-18:00	**0800-1800**	**08:00-18:00**
15	20	5

**Contractor Staff – engineering and support staff to direct and project manage the engineering work and site.*
***Labour – those working on site doing engineering, construction and manual work.*
****Client Staff – engineering and support staff managing the project and supervising the Contractor*

Code of Construction Practice

10.2.9 Measures applicable to all sites are incorporated into the *Code of Construction Practice (CoCP)*[i] to limit significant adverse air quality, construction dust (see Section 7), noise, vibration (see Section 6), and visual impacts (see Section 4). These measures could also reduce socio-economic effects, particularly amenity effects.

10.2.10 The *CoCP part A* has confirmed that the contractor will carry out the works in such a manner as to limit undue inconvenience to the public and other river users arising from increased barge movements, as far as is reasonably practicable. It also states that a *River Transport Management Plan* would be produced which would include assessment of risks to river users and consider the potential for mitigation measures that can be employed (see Section 5 within the *CoCP Part A*).

10.2.11 The *CoCP Part A* also confirms that all land, including highways, footpaths, public open spaces, river embankments / waterways, loading facilities or other land occupied temporarily would be made good to the satisfaction of Thames Water[ii] and the local authority where required. This would be in accordance with the Ecology and landscape management plan and the approved landscape design for the site (see Section 4 within the *CoCP Part A*).

10.2.12 Further site specific measures, which could reduce socio-economic effects and particularly amenity effects, are incorporated into the *CoCP Part B*. See the *CoCP* sections in the air quality and odour, noise and vibration, and townscape and visual construction effect assessments (Sections 4.2, 9.2 and 11.2 respectively within this Vol) for details on the type of measures that would be employed.

10.2.13 The *CoCP Part B* states that the Thames Path diversion would be clearly signed (see Section 5 within the *CoCP Part B*).

10.2.14 If Option A were taken forward, access to Lacks Dock for Duck Tours would be maintained throughout the works unless agreed otherwise (see Section 5 within the *CoCP Part B*). A traffic marshal would be stationed at the entrance to Lacks Dock to manage Duck Tours and construction traffic vehicle movements and ensure that no vehicles queue on Albert Embankment. The existing security barrier and kiosk would be temporarily relocated on the opposite side of the entrance to Lacks Dock for the duration of the construction period.

Operation

10.2.15 The installation of above ground structures, as described in Section 3 of this volume, would result in the extension of the existing river wall out into the River Thames. This would create a small new area of public amenity

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[i] *CoCP* is provided in Vol 1 Appendix A. It contains general requirements (Part A), and site specific requirements for this site (Part B).

[ii] Thames Water Utilities Ltd (TWUL). The Draft Development Consent Order (DCO) contains an ability for TWUL to transfer powers to an Infrastructure Provider (as defined in article 2(1) of the DCO) and/or, with the consent of the Secretary of State, another body.

space north of Lacks Dock at the same level as the existing Thames Path, available for passive recreational use by the public.

Environmental design measures

10.2.16 Measures which have been incorporated into the design of the proposed development (described in the design principles) include the:

a. access to Lacks Dock which would be retained for London Duck Tours Ltd and their security kiosk and vehicle barrier would be reinstated in its existing location

b. replacement of any planting along Lacks Dock lost during construction

c. elevation of the public realm to the existing flood defence level to encourage views across the River Thames to the Palace of Westminster World Heritage Site and Tate Britain

d. diversion of the Thames Path over the foreshore structure in order to improve and widen it, to a minimum width of four metres across the foreshore structure

e. positioning of seating to maximise views towards the Palace of Westminster World Heritage Site

f. planting of additional trees on the structure to separate the Thames Path from the seating area

g. incorporation of interpretive materials and information on the views and historic interest of the site

h. imaginative and attractive design of paving on the top of the structure

10.3 Assessment methodology

Engagement

10.3.1 Vol 2 documents the overall engagement which has been undertaken in preparing the *Environmental Statement*. Specific comments relevant to this site for the assessment of socio-economics are presented in Vol 16 Table 10.3.1.

Vol 16 Table 10.3.1 Socio-economics – stakeholder engagement

Organisation	Comment	Response	Further details provided in
London Borough (LB) of Lambeth, February 2012	Satisfactory arrangements should be agreed with the Council in respect of appropriately signed pedestrian arrangements for the diversion of the Thames Path during the period of construction work, including provision for	The impact of the diversion of the Thames Path on all users has been considered. It is noted that appropriate signage would be provided, as set out in the *CoCP*.	Section 10.5 and *CoCP*

Organisation	Comment	Response	Further details provided in
	disabled people.		
Port of London Authority (PLA), February 2012	The PLA needs to be assured that the operations of London Duck Tours, both on and in the vicinity of Lacks Dock, can be appropriately maintained during both the temporary works and permanently.	Consideration of the impact of the proposed development at the site on the Duck Tours business has been considered as appropriate in relation to Option A and Option B. See also the Navigational Risk Assessment for this site submitted as part of the application.	Section 10.5
London Councils, February 2012	The noise, pollution and congestion caused by site traffic will impact on quality of life for local residents.	Consideration of the impact of the proposed development on residential amenity has been considered as part of this assessment in relation to Option A and Option B.	Section 10.5
LB Lambeth, Oct 2012	If both Lacks Dock and Camelford / Tintagel House access routes were operational, this would have a negative impact on pedestrians and cyclists diverted from the closed section of the Thames Path.	The *CoCP* makes provision for ensuring that the Thames Path diversion would be adequate signed and managed for the convenience and safety of users as set out in the *CoCP* Section 5.3. This assessment considers the effect on the amenity of users of the diverted Thames Path. In regard to effects related to construction traffic accessing the site, these are considered in Section 12 of this volume	Section 10.5, *CoCP* and Section 12 of this volume

Baseline

10.3.2 The baseline methodology follows the methodology described in Vol 2 Section 10. There are no site specific variations for identifying the baseline conditions for this site.

Construction

10.3.3 For this site, the base case is the peak year of construction works. The assessment area is as set out in Vol 2 Section 10.5.

10.3.4 The assessment methodology for the construction phase follows that described in Vol 2 Section 10. There is one site specific variation for undertaking the construction effects assessment of this site which is that the potential for effects on the amenity of office workplaces has been considered at this site. This is due to the proximity of the proposed construction site to existing office buildings and the likelihood for there to be significant noise, and therefore amenity effects, on such a receptor at this site.

10.3.5 Section 10.5 details the likely significant effects arising from the construction at Albert Embankment Foreshore. There are no other Thames Tideway Tunnel project sites which could give rise to additional effects on socio-economics within the assessment area for this site, therefore no other project sites are considered in this assessment.

10.3.6 Of the developments listed in the site development schedule (see Vol 16 Appendix N), the six developments which are considered relevant in the construction assessment base case are:

a. 2-14 Tinworth Street and 108-110 Vauxhall Walk, approximately 120m northeast of the site, including residential and commercial and community floorspace as well as public realm improvements

b. Eastbury House, approximately 150m northeast of the site, including residential floorspace with mixed uses on the ground floors

c. Hampton House, approximately 230m from the site, including residential and other commercial and community floorspace

d. 1-9 Bondway / 4-6 South Lambeth Place, approximately 185m southeast, including hotel and commercial floorspace

e. Riverwalk House, approximately 160m west, residential and other commercial and community floorspace

f. St George Wharf (Vauxhall Tower), approximately 200m south of the site, including residential and other commercial and community floorspace, including provision of new riverfront public amenity space associated with the realignment of the Thames Path.

10.3.7 These developments would be fully complete and operational by Site Year 1 of construction (which is also the peak year of construction at this site), thereby being present in the base case year. They would alter the existing baseline by increasing the number of potentially sensitive residential receptors within 250m of the site. In the case of the development at St George Wharf (Vauxhall Tower), it would also result in the realignment of the Thames Path along the river and improve the quality of this recreational asset. The other schemes which would be completed and operational in the base case outlined in the development schedule (Vol 16 Appendix N) are beyond the 250m amenity assessment area and therefore no additional receptors have been considered for the construction base case.

10.3.8 Of the developments listed in the site development schedule (see Vol 16 Appendix N), one has been considered in the construction assessment for cumulative effects; the Vauxhall Square Cap Gemini site development, located approximately 250m south of the site, would be under construction during the peak year of construction of the Thames Tideway Tunnel at this site. Therefore, given its distance from the site at Albert Embankment Foreshore, it could lead to cumulative amenity impacts on nearby sensitive receptors between the two sites during the construction of the Thames Tideway Tunnel project at this site. All other schemes are assumed to be complete and operational by the peak year of construction or are located outside of the assessment areas considered within the assessment at this site and as such are not relevant to the cumulative assessment.

Operation

10.3.9 The base case is Year 1 of operation. The assessment area is as set out in Vol 2 Section 10.5.

10.3.10 The assessment methodology for the operational phase follows that described in Vol 2 Section 10. There are no site specific variations for undertaking the operational assessment of this site.

10.3.11 Section 10.6 details the likely significant effects arising from the operation at Albert Embankment Foreshore. There are no other Thames Tideway Tunnel project sites which could give rise to additional effects on socio-economics within the assessment area for this site, therefore no other Thames Tideway Tunnel project sites are considered in this assessment.

10.3.12 Of the developments listed in the site development schedule (see Vol 16 Appendix N), there are none which would introduce new receptors into the operational base case; significantly alter circumstances for those receptors covered by the operational assessment; or which would give rise to cumulative effects. This is because the only receptor covered in the operational assessment is users of the new public amenity space and none of the developments would directly affect those users.

Assumptions and limitations

10.3.13 The assumptions and limitations associated with this assessment are presented in Vol 2 Section 10. There are no assumptions and limitations specific to the assessment of this site.

10.4 Baseline conditions

Current baseline

10.4.1 The following section sets out the baseline conditions for socio-economics within and around the site, including a description of the local social and economic context, and a description of the receptors relevant to this assessment. Future baseline conditions (base case) are also described.

Local context

10.4.2 The surrounding area within 250m of the site comprises a mix of residential and commercial uses, including apartment towers and mixed use complexes (eg, St George Wharf), retail and bar / restaurant uses and office buildings (see Vol 16 Figure 2.1.2 in separate volume of figures). The area also contains a major transport hub, with mainline and underground train stations and a bus station situated at Vauxhall Cross interchange. Recreational facilities within the area include the Thames Path and River Thames, and a number of small open spaces and local parks. Within 1km of the site there are a mix of land uses including residential communities on both sides of the river and the Nine Elms Lane former employment precinct to the south.

Community profile

10.4.3 A detailed community profile is outlined in Vol 16 Appendix H.1[iii]. The following points provide a summary of the community profile and provide context for this socio-economic assessment:

a. The resident population was approximately 600 people within 250m of the site[iv] and approximately 39,550 within 1km[v] at the time of the last census for which data is available[vi].

b. Within 250m, the proportion of under 16 year olds (14.7%) is slightly lower than within 1km (16.4%) and somewhat lower than the LB of Lambeth (19.2%) and Greater London (20.2%).

c. Within 250m, the proportion of over 65 year olds (12.3%) is similar to that recorded within 1km (12.3%) and Greater London (12.4%).

d. Within both 250m and 1km, Black and Minority Ethnic (BME) groups make up a little fewer than 30% of all residents. This is similar to the average across Greater London (28.8%) but somewhat lower than the LB of Lambeth average (37.6%).

e. The proportion of Black residents within both 250m (16.9%) and 1km (17.1%) is somewhat higher than for Greater London (10.9%). By contrast, the proportion of Asian residents within 250m (2.7%) and 1km (4.6%) is considerably lower than Greater London (12.1%).

[iii] Information sources are provided in the appendix.

[iv] The statistics presented for the study area within 250m of the site include only that area on the same side of the River Thames as the proposed development.

[v] The statistics presented for the study area within 1km of the site include both sides of the River Thames.

[vi] Census 2001. This type of data for the 2011 Census had not been released at the time of the assessment.

f. Within 250m, the proportion of residents who suffer from a long term or limiting illness (13.8%) is somewhat lower than within both the LB of Lambeth (14.7%) and Greater London (15.5%). The proportion of residents within 250m who claim disability allowance (8.4%) is considerably higher than across Greater London (4.5%).

g. General health within the LB of Lambeth is fair relative to Greater London overall, with a moderate incidence of adults and children undertaking physical exercise and moderate level of adult obesity, though the incidence of child obesity is relatively high.

h. Relative to Greater London, death rates caused by respiratory disease within 250m are low, whereas deaths resulting from cancer are high. Male and female life expectancy is relatively low compared to Greater London overall.

i. Within 250m, around 55% of households do not own cars, increasing to almost 60% within 1km. This is compares with Greater London where a little over one third of all households do not own a car.

j. The data on deprivation in the local area is mixed. The incidence of overall deprivation within 250m (73.8%) is considerably higher than that recorded for Greater London (24.5%). In contrast, income deprivation within 250m (30.8%) is considerably lower than for Greater London (12.4%). The incidence of deprivation within 1km is similar to the LB of Lambeth and Greater London at around approximately one third of households.

10.4.4 The community profile suggests that the local community is diverse with high proportions of White and Black residents. Residents generally experience relatively fair health but have low life expectancy. Local residents within 250m experience relatively high rates of overall deprivation, though the incidence of income deprivation is relatively low.

10.4.5 It should be noted that the ongoing development and occupation of St George Wharf residential complex over the last decade is likely to have altered the local community profile since these data were collated.

Economic profile

10.4.6 An economic profile (based on 2012 data) is outlined in Vol 16 Appendix H.2. The following points provide a summary of the profile and provide context for this socio-economic assessment:

a. Within 250m of the site there are approximately 4,900 jobs and 420 businesses[vii].

[vii] Source: Experian 2012. Data is aggregated for seven digit post-code units falling wholly or partially within a 250m boundary of the limits of land to be acquired or used (LLAU), including post code units on the opposite side of the River Thames if relevant. Employee data reflect a head count of workers on-site rather than Full Time Equivalent (FTE) jobs. The count of businesses relates to business 'locations' or 'units'; an enterprise may have a number of business locations / units.

b. The three largest sectors as measured by employment within approximately 250m are; Human Health and Social Work Activities; Accommodation and Food Services Activities; and Wholesale and Retail Trade Activities.

c. The three largest sectors as measured by number of businesses within approximately 250m are; Administration and Support Services; Professional Scientific and Technical Activities; and Information and Communication.

d. At all geographical levels, most businesses fall within the smallest size band (1 to 9 employees). However, within 250m of the site, businesses appear on average to be slightly larger than within LB of Lambeth and Greater London as a whole.

a. The leading sectors measured by employment and number of businesses within 250m vary greatly by size. For example, 30% of Human Health and Social Work businesses employ over 25 employees compared with 2% in Administrative and Support Services.

Receptors

Thames Path

10.4.7 The Thames Path is a recreational asset and national trail. It follows the river for almost its entire length and in west and central London it runs on both sides of the river. The Thames Path at this location forms part of the Albert Embankment, directly adjacent to the River Thames foreshore in the form of a pedestrian promenade separated from local roads. It connects users with the Nine Elms Battersea development precinct to the south, and Lambeth Bridge approximately 550m to the north.

10.4.8 Vol 16 Figure 10.4.1 (see separate volume of figures) shows the location of this receptor.

10.4.9 The Thames Path runs under Vauxhall Bridge through a pedestrian subway and there is access from the path up to Vauxhall Bridge Road on both sides of the bridge.

10.4.10 To the north of Vauxhall Bridge, the Thames Path is varied in terms of its width and landscaping. The path is flanked by commercial office and residential buildings. A section of the path in front of the Vauxhall Cross building functions as an amenity space, with several bench seats offering views across the river to the north bank of the Thames towards Millbank and the Tate Britain gallery.

10.4.11 To the south of Vauxhall Bridge, the path has been recently paved and landscaped as part of the St George Wharf development. Several restaurant / café businesses also have outdoor seating areas overlooking the path.

10.4.12 The usage surveys (see Vol 16 Appendix H.3) recorded a peak of 430 movements per hour (west of the Vauxhall Cross building) during the weekday surveys. The weekend peak was considerably lower, with a peak figure of 114 movements per hour. The path was busiest during lunchtime and peak evening travel periods, when a considerable number of local office workers were recorded. The majority of users (over 75% on each survey day) were young adults (18 to 39 years old). Tourist use appears to be relatively low or largely non-existent.

10.4.13 The usage survey results (see Vol 16 Appendix H.3) are corroborated by pedestrian usage surveys undertaken as part of the transport assessment (see Section 12 of this volume) which recorded a peak of approximately 170 pedestrians during the AM peak hour and 143 pedestrians during the PM peak hour. On the basis of this data and the usage surveys it is concluded that the Thames Path is moderately used at this location.

10.4.14 The main factor affecting the sensitivity of users of the Thames Path is the availability of alternatives:

a. As a metropolitan-wide recreational asset, users have access to a number of comparable stretches of the Thames Path on both sides of the river across central London.

b. More locally, considering the section of path that would be affected, there is an accessible alternative route via Albert Embankment and Vauxhall Bridge Road although it diverts users away from the river and past busy roads, and includes the need to cross Vauxhall Bridge Road.

10.4.15 In terms of their sensitivity to amenity impacts, pedestrians using the Thames Path are only likely to be near the proposed construction site for the time that it takes them to pass by (likely to be a minute or two for most users). Therefore the duration for which users could experience amenity effects would be limited.

10.4.16 Taking account of the above factors, the sensitivity of users of the Thames Path to impacts associated with the project would be low.

Public amenity space (future) associated with the Thames Path

10.4.17 An area of public amenity space would be created as part of the proposed development, to the north of Lacks Dock.

10.4.18 This space would be equivalent in size to a pocket park as categorised by the *London Plan's Open Space Hierarchy*. It could also be categorised as being part of a linear open space given its position on the Thames Path. Open spaces of pocket park size typically serve a catchment area of less than 400m with linear open spaces serving no fixed catchment area but being accessible to users wherever feasible (GLA, 2011)[2].

10.4.19 In terms of the value of this space and the consequent sensitivity of users, the availability of alternative similar spaces is a key factor to consider. The adjacent Thames Path was found to be moderately used, as outlined in para. 10.4.12. However, the river in this location is flanked on both sides by public amenity areas associated with the Thames Path offering comparable facilities and functionality. Additionally, Albert Embankment Gardens are situated alongside the Thames Path approximately 85m north of the site.

10.4.20 Accordingly, it is considered that the sensitivity of users of the future riverside public amenity space to the creation of additional public amenity space would be low.

Business – Duck Tours (users of Lacks Dock slipway)

10.4.21 Lacks Dock, situated between the Vauxhall Cross building and Camelford House, provides direct access via a slipway to the River Thames from Albert Embankment.

10.4.22 Vol 16 Figure 10.4.1 (see separate volume of figures) shows the location of this receptor.

10.4.23 The slipway is privately operated and used solely by Duck Tours, which operate DUKW amphibious vehicles to provide a year round land and river tour bus service that is mainly patronised by tourists (London Duck Tours, 2012)[3].

10.4.24 Duck Tours is the sole user and lease holder of the Lacks Dock slipway. The nearest accessible slipway for boat launching (on the south bank of the River Thames) is approximately four miles away at Putney Bridge foreshore to the west or at Borthwick Wharf to the east.

10.4.25 Although there are other tour bus services aimed at the tourist market in London, Duck Tours, by virtue of its amphibious DUKW vehicles, is considered to be a unique business. It is estimated that the business would employ between 10 and 49 employees, making it a small size enterprise. Its drivers would be specially trained to operate the amphibious vehicles that the business uses.

10.4.26 Duck Tours depends on Lacks Dock to access the river as there are no other suitable access points in central London. However, if suitable access and management arrangements were put in place, it would be possible for other activities to make use of the access route and slipway during the proposed construction works.

10.4.27 Taking account of these factors, it is considered that the sensitivity of Duck Tours to the temporary disruption of Lacks Dock slipway would be medium.

Residential

10.4.28 There are existing and base case residential developments, including Bridge House, Peninsula Heights and St George Wharf near the proposed construction site, as outlined in the air quality and odour, noise and vibration and visual assessments.

10.4.29 Land that is predominantly used for residential development is shown in the land use plan for this site, see Vol 16 Figure 2.1.2 (see separate volume of figures).

10.4.30 It is considered that the sensitivity of nearby residents to overall amenity effects would vary by time of day, with residents being somewhat less sensitive to amenity effects, particularly noise, during the day and more sensitive to such effects during the evening and night.

10.4.31 Therefore, as outlined in the methodology for this socio-economic impact assessment (see Vol 2 Section 10) the sensitivity of nearby residential receptors to amenity impacts would be medium during the day and high during the evening and night.

Summary

10.4.32 A summary of receptors as described in the baseline and their sensitivity is provided in Vol 16 Table 10.4.1.

Vol 16 Table 10.4.1 Socio-economics – receptor values / sensitivities

Receptor	Value / sensitivity and justification
Users of the Thames Path	Low – alternative routes are available at both metropolitan and local levels, although the local alternatives do not provide river views. Most users would only be near the site for a short duration.
Users of the public amenity space (future) associated with the Thames Path	Low – future users have access to alternative areas of amenity space in association with the Thames Path on both sides of the river, including Albert Embankment Gardens.
Business – Duck Tours (users of Lacks Dock slipway)	Medium – there is no practical alternative slipway available for use by Duck Tours in central London however it is believed that the business operation would be able to be maintained during the proposed construction works. The business itself is unique as the only amphibious tour in London.
Residents	Medium / High – residents would have limited opportunity to avoid effects. They would have medium sensitivity to amenity effects overall during the day and high sensitivity to amenity effects overall during the evening and night.

Construction base case

10.4.33 The construction assessment year and area are as set out in para. 10.3.3.

10.4.34 The base case in the peak year of construction, taking into account the schemes described in para. 10.3.6, would differ from the baseline in the following ways:

a. There would be an increase in the number of residential receptors within 250m of the site.

b. In association with the new development, particularly the Land at St George Wharf (Vauxhall Tower) the Thames Path would be realigned along the waterfront connecting it to with the existing riverfront sections at Tideway Walk further south.

c. The number of people making use of facilities such as the Thames Path would increase in line with the increase in the number of workers and residents within the nearby area including further south within the Nine Elms Battersea regeneration area (although it is assumed that numbers would not peak until sometime after the completion of construction).

10.4.35 It is understood that due to the existing lease conditions of Lacks Dock slipway the use of the slipway is unlikely to change between the current time and the base case year. Therefore it is assumed that under the base case scenario the slipway would continue to be used as it is currently with Duck Tours as the sole user.

10.4.36 Other than the developments outlined above, it is assumed that the other base case socio economic conditions at the site would remain largely the same as existing baseline conditions.

Operational base case

10.4.37 The operational assessment year and area are as set out in para. 10.3.9.

10.4.38 As described in para. 10.3.9, there are no developments relevant to the operational assessment within the assessment area that would alter the base case.

10.5 Construction effects assessment

Temporary diversion of the Thames Path

10.5.1 The proposed construction works would result in the Thames Path being temporarily diverted via the pavement of Albert Embankment and Vauxhall Bridge Road during the construction phase.

10.5.2 The magnitude of the impact is influenced by the following factors:

a. The diversion would occur over a medium term period and would be temporary.

b. On the basis that the number of users of the Thames Path is likely to increase up to the base case year as residential developments in the area become occupied, the diversion would affect a moderate to high number of users, many of whom would be local office workers during weekdays but also existing new residents from developments further south.

c. This diversion would route users away from the river and past a busy road junction, following a slightly longer route than the existing path. The quality of the paths and surrounding environment along the diversion route is reasonable, even though the route does not run along the riverfront and instead runs alongside busy roads. Given the intention within the *CoCP* to install adequate signage, the diversion route should not be disorientating for users. There may be additional time required to navigate the diversion route which would add approximately 250m (equivalent to approximately two to three minutes at average walking speeds) to the length of the route.

d. The two existing signalised pedestrian crossings would allow pedestrians to cross the road safely at the intersection of Wandsworth Road and Vauxhall Bridge Road.

10.5.3 On the basis of the above factors, the magnitude of impact arising from the diversion of the Thames Path would be medium.

10.5.4 Given the medium magnitude of impact and low sensitivity of users, the effect of the diversion on Thames Path users would be **minor adverse**.

Effect on a business (Duck Tours – users of Lacks Dock slipway) as a result of construction activity

Option A: Access via Lacks Dock

10.5.5 In order to provide vehicle access to the construction site area, a construction access / haul route would be constructed alongside the slipway access route from Albert Embankment to Lacks Dock, thereby running parallel to the existing slipway access route. The existing security kiosk and barrier would be temporarily relocated to the north side of the slipway and access would be maintained for Duck Tours' vehicles. Closure of the slipway would not be required; however, the creation of a loading dock at the foot of Lacks Dock and the delivery of large items of plant (for example, cranes or excavators) might occasionally result in a temporary disruption to Duck Tours access.

10.5.6 The magnitude of the impact is influenced by the following factors:

a. The use of the construction route parallel to the slipway access route used by Duck Tours would occur for a medium term period. However, the layout would mean that Duck Tours would effectively be able to operate its services and timetable unimpeded.

b. As described in the *CoCP*, access would be maintained for Duck Tours unless otherwise agreed. A traffic marshal would be stationed at the site entrance to manage access to the construction site via this route in order to avoid congestion or queuing of vehicles waiting to use the slipway onto Albert Embankment. These measures would help to limit the impact on Duck Tours.

c. During construction, and then afterwards in the operational phase, the position of the cofferdam would narrow the waterside approach to the slipway from the river. However navigational issues have also been taken into account during the design of the scheme. As described in the *CoCP*, a *River Transport Management Plan* would also be produced which would include assessment of risks to river users and consider the potential for mitigation measures that can be employed.

10.5.7 On the basis of the above factors, it is considered that the magnitude of the impact would be low.

10.5.8 Given the low magnitude of impact and medium sensitivity, the effect on the Duck Tours business as a result of construction activity under Option A would be **minor adverse**.

Option B: Access between Camelford House and Tintagel House

10.5.9 Under Option B, an access / haul route would be created via the existing private road between Camelford House and Tintagel House and would be used as an alternative to the route running parallel to the route alongside the access to Lacks Dock.

10.5.10 As a result, the number and frequency of construction vehicles accessing the site alongside the Lacks Dock access route would be less than under Option A. Construction vehicles would occasionally need to be routed along Lacks Dock during the construction phase but only during the delivery of large items of plant (for example, cranes or excavators) and for vehicles required to move material between working areas via the foreshore link. The size and position of the proposed cofferdam would not be any different in this option.

10.5.11 It is considered that the implications for Duck Tours under Option B would be similar to that under Option A, although there would be considerably fewer opportunities for inconvenience to arise because most of the vehicles accessing the site would not go via Lacks Dock. Duck Tours' access to Lacks Dock would continue to be maintained except where agreed and the position of the cofferdam would be the same.

10.5.12 As such, it is considered that the magnitude of the impact would be negligible.

10.5.13 Given the negligible impact magnitude and medium sensitivity of Duck Tours, the effect on the Duck Tours business as a result of construction activity under Option B would be **negligible**.

Effect on the amenity of Thames Path users

10.5.14 Assessments have been undertaken to examine the likelihood of significant air quality, construction dust, noise, vibration and visual effects of the project arising during construction. For further information refer to the respective construction effects sections within this volume (see Section 4 Air quality and odour, Section 9 Noise and vibration, and Section 11 Townscape and visual). The following points summarise the residual effect findings of those assessments in relation to the Thames Path:

a. Both local air quality effects and construction dust effects would be **negligible**.

b. No noise and vibration receptors were identified as requiring assessment in relation to the Thames Path.

c. At the four viewpoints located within 250m of, and on the same side of the River Thames as, the site visual effects would be **major adverse** from two viewpoints (2.4 and 2.5) and **moderate adverse** at the remaining two viewpoints (2.3 and 2.6).

10.5.15 In assessing the overall magnitude of impact, the above findings have been taken into consideration together with the following factors that are considered relevant to the receptor's overall experience of amenity at the site:

a. Given the four and a half year construction programme, the effects noted above would be likely to be experienced over a medium term period.

b. The use of the Thames Path at this site means that any impacts would affect a moderate to high number of users in the base case year.

c. The experience of adverse visual impacts for users is likely to be limited, due to route of the Thames Path diversion and the position of the Vauxhall Cross, Tintagel House and Camelford House along the diversionary route which would shield users' views from the diverted Thames Path of the construction site. The major adverse visual impact would be from the southern end of Vauxhall Bridge and at either end of the approach leading up to the diversion route. Users would therefore be passing the viewpoint from a considerable distance away from the site, rather than passing directly adjacent to the site and therefore the experience of visual amenity impacts would be limited.

d. Given that the Thames Path, in terms of its function as a recreational asset, is mostly used for walking, jogging and cycling, the time taken to pass by the site would be a relatively short period of time (eg, up to five minutes) for most users.

10.5.16 On the basis of the above findings and factors, it is considered that the overall amenity impact magnitude would be low.

10.5.17 Given the low impact magnitude and low sensitivity, it is assessed that the effect on the amenity of Thames Path users would be **negligible**.

10.5.18 The option of accessing the site from between Camelford House and Tintagel House (Option B), rather than solely via Lacks Dock (Option A), would not alter any of the effect findings summarised from Section 4, Section 9, and Section 11 of this volume. As such the effects for this option are the same as those presented above.

Effect on the amenity of residents

10.5.19 Assessments have been undertaken to examine the air quality, construction dust, noise, vibration, and visual effects of the project arising during construction. For further information refer to the respective construction effects sections within this volume (see Section 4, Section 9, and Section 11). The following points summarise the residual effect findings of those assessments in relation to residential receptors:

a. Both local air quality effects and construction dust effects would be **minor adverse** at two (Bridge House and Peninsula Heights) of the ten receptors identified and **negligible** at the remaining eight.

b. Noise effects would be **not significant** at all of the four residential receptors identified. Noise effects arising from road based and river based construction traffic would also be **not significant**. Vibration effects would be **significant** at one (Bridge House)[viii] of the four residential receptors identified and **not significant** at the remaining three.

c. No visual effects were identified as requiring assessment in relation to residential receptors on the same side of the River Thames and within 250m of the proposed construction site.

[viii] The noise and vibration assessment reports that the residual vibration effect for Bridge House is considered not significant subject to successful implementation of low vibration piling as set out in the *CoCP* (see Vol 16 Section 9.9).

10.5.20 In assessing the overall magnitude of impact, the above findings have been taken into consideration together with the following factors that are considered relevant to the receptor's overall experience of amenity at the site:

a. Given the four and a half year construction programme, the effects noted above would be likely to be experienced over a medium term period. The exception is that local air quality effects may not be minor adverse over the whole construction period as the assessment is purely based on the peak construction year and these effects may be negligible in other years.

b. While it is assessed that there would be significant vibration effects at one of four receptors, the noise and vibration assessment states that the duration of this impacts would be likely to be short.

10.5.21 On the basis of the above findings and factors, it is considered that the magnitude of overall amenity impacts would be low.

10.5.22 Given the low magnitude of the impact and medium sensitivity of residents, the effect on the amenity of a limited number of residential receptors located closest to the site would be **minor adverse**.

10.5.23 This assessment relates to those residential receptors which would experience adverse local air quality, construction dust and vibration effects. For residential receptors not subject to these effects, it is considered that there would be a negligible effect on their amenity.

10.5.24 The option of accessing the site from between Camelford House and Tintagel House (Option B), rather than solely via Lacks Dock (Option A), would not alter any of the effect findings summarised from Section 4, Section 9, and Section 11 above. As such the effects for this option are the same as those presented above.

10.6 Operational effects assessment

Permanent gain of public amenity space

10.6.1 The extension of the river wall out into the river foreshore would result in the permanent provision of an area of landscaped publicly accessible amenity space to the north of Lacks Dock, measuring a total of approximately 950m^2 in size.

10.6.2 The magnitude of the impact is influenced by the following factors:

a. The proposed extension of the river wall and creation of new public amenity space associated with the Thames Path would provide permanent and additional opportunities to users for passive recreation.

b. The area of amenity space would amount the addition of an area equivalent to a pocket park (in line with the GLA Open Space hierarchy [GLA, 2011]); serving people living and working within 400m of the site and other users of the Thames Path from a wider catchment area.

c. Assuming an increased level of use of the Thames Path in the base case operational year, the new space is likely to benefit a high number of users.

d. Users of the amenity space at Albert Embankment Gardens engaging in passive recreation would have increased access to an additional area of amenity space suitable for passive recreation. This would benefit employees, local residents and visitors to the area.

10.6.3 Taking account of the above, it is considered that the magnitude of impact would be medium.

10.6.4 Given the medium magnitude of impact and low sensitivity, it is considered that the effect on users of the permanent gain of public amenity space would be **minor beneficial**.

10.7 Cumulative effects assessment

Construction effects

10.7.1 For the purposes of this cumulative assessment, the assessment year is the peak construction year.

10.7.2 As described in Section 10.3, there is one project, the Vauxhall Square Cap Gemini, which is within the assessment areas relevant to the effect assessments undertaken at this site and which would be under construction during the peak year of construction.

10.7.3 In respect of non-amenity related effect assessments undertaken in Section 10.5, as this development is not located on or within the proposed project site, it would not be possible for it to give rise to cumulative effects on the business (Duck Tours) that makes use of Lacks Dock or on the diversion of the Thames Path nearby the site.

10.7.4 In respect of the amenity effect assessments undertaken in Section 10.5, the development is located within the assessment area for amenity effects.

10.7.5 However, the air quality and odour, noise and vibration and townscape and visual cumulative effect assessments (see Section 4, Section 9 and Section 11 respectively) have concluded that there are unlikely to be cumulative effects from the Vauxhall Square Cap Gemini development and the development at Albert Embankment Foreshore which would have an elevated or significant effect on nearby sensitive receptors considered within their respective assessments and which are relevant to the amenity related effect assessments undertaken in Section 10.5. Therefore, it is considered that the development would not affect the significance of the effects on the amenity of sensitive receptors located near the site.

10.7.6 Therefore, the socio-economic effects would remain as described in Section 10.5.

Operational effects

10.7.7 As described Section 10.3, there are no other developments that could have the same type of effect as that considered in Section 10.6 and there would be no cumulative effects.

10.7.8 Therefore, the socio-economic effects would remain as described in Section 10.6.

10.8 Mitigation

Construction

10.8.1 The above assessment has concluded that there would not be any major or moderate adverse effects in the construction phase that would require mitigation.

Operational

10.8.2 The above assessment has concluded that operational effects would be beneficial and therefore mitigation is not needed.

10.9 Residual effects assessment

Construction effects

10.9.1 As no additional mitigation measures are proposed, the residual construction effects remain as described in Section 10.5.

10.9.2 All residual effects are presented in Section 10.10.

Operational effects

10.9.3 As no mitigation measures are proposed, the residual operational effects remain as described in Section 10.6.

10.9.4 All residual effects are presented in Section 10.10.

10.10 Assessment summary

Vol 16 Table 10.10.1 Socio-economics – summary of construction assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Users of the Thames Path	Temporary diversion of Thames Path	Minor adverse	None	Minor adverse
Business: Duck Tours (users of Lacks Dock slipway)	Option A: Effect on Duck Tours as a result of construction activity	Minor adverse	None	Minor adverse
	Option B: Effect on Duck Tours as a result of construction activity	Negligible	None	Negligible
Users of the Thames Path	Effect on the amenity of Thames Path users as a result of construction activity	Negligible	None	Negligible
Residents	Effect on the amenity of residents	Minor adverse	None	Minor adverse

Vol 16 Table 10.10.2 Socio-economics – summary of operational assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Future users of Thames Path and public amenity space	Permanent gain of public amenity space	Minor beneficial	None	Minor beneficial

References

[1] Department of Environment, Food and Rural Affairs. National Policy Statement for Waste Water (2012). Available from: http://www.defra.gov.uk/publications/files/pb13709-waste-water-nps.pdf. Accessed November 2012

[2] Greater London Authority (GLA). *The London Plan 2011* (2011), p.234

[3] London Duck Tours. Available from: http://www.londonducktours.co.uk/about-us/general-information. Accessed on: 28/06/2012

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.16**

Volume 16: Albert Embankment Foreshore site assessment

Section 11: Townscape and visual

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Thames Tideway Tunnel

Environmental Statement

Volume 16: Albert Embankment Foreshore site assessment

Section 11: Townscape and visual

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11 Townscape and visual

11.1 Introduction

11.1.1 This section presents the findings of the assessment of the likely significant effects of the proposed development on townscape and visual amenity at Albert Embankment Foreshore. The assessment describes the current conditions found within and around the site – the nature and pattern of buildings, streets, open space and vegetation and their interrelationships within the built environment – and the changes that would be introduced as a result of the proposed development during construction and operation.

11.1.2 The effects of these changes during construction and operation are assessed. The construction phase assessment includes effects on townscape character areas and visual effects during daytime. The Year 1 operational phase assessment includes effects on townscape character areas and visual effects during both daytime and night time. The Year 15 operational assessment includes effects on townscape character areas and visual effects during daytime. The assessment also identifies mitigation measures where appropriate.

11.1.3 Effects arising from lighting during the construction phase have not been assessed. This is on the basis that there would not be any significant effects (this is further explained in para. 11.3.19).

11.1.4 Each section of the assessment is structured so that townscape aspects are described first, followed by visual.

11.1.5 The assessment of the likely significant townscape and visual effects of the project has considered the requirements of the National Policy Statement (NPS) for Waste Water (Defra, 2012)[1]. In line with these requirements, the townscape and visual assessment considers effects during construction and operation on townscape components, townscape character and visual receptors. The construction and design of the proposed development also takes account of townscape and visual considerations in line with the NPS recommendations. Vol 2 Section 11 provides further details on the methodology.

11.1.6 Plans of the proposed development as well as figures included in the assessment for this site are contained in a separate volume (Volume 16 Albert Embankment Foreshore Figures).

11.1.7 A separate but related assessment of effects on the setting of heritage assets is included in Section 7 Historic environment.

11.2 Proposed development relevant to townscape and visual

11.2.1 The proposed development is described in Section 3 of this volume. The elements of the proposed development relevant to the townscape and visual assessment are set out below.

Construction

11.2.2 The specific construction works which may give rise to effects on townscape character and visual receptors are listed as follows, with the activities likely to give rise to the most substantial townscape and visual effects described first:

a. use of cranes during shaft sinking and secondary lining of the connection tunnel

b. construction of a temporary cofferdam using a piling rig

c. provision of welfare facilities, assumed to be a maximum of three storeys in height

d. installation of 3.6m high hoardings around the boundary of the construction site

e. vehicular construction access to the site via either Lack's Dock (Option A) or a temporary road access between Camelford House and Tintagel House (Option B).

Code of Construction Practice

11.2.3 The *Code of Construction Practice (CoCP)* is provided in Vol 1 Appendix A. It contains general requirements (*Part A*), and site specific requirements for this site (*Part B*). Measures incorporated into the *CoCP Part A* to reduce townscape and visual impacts include:

a. protection of existing trees in accordance with BS5837 'Trees in Relation to Construction – Recommendations' (see *CoCP Part A* Section 11)

b. protection of listed structures (see *CoCP Part A* Section 12)

c. installation of well-designed visually attractive hoardings (see *CoCP Part A* section 4)

d. the use of appropriate capped and directional lighting when required (see *CoCP Part A* Section 4).

11.2.4 Measures incorporated into the *CoCP Part B* to reduce townscape and visual impacts include:

a. provision for incorporating suitable art work and viewing windows

b. use of 3.6m high hoardings.

Operation

11.2.5 The particular components of importance to this topic include the:

a. design, layout and materials used in the public realm including planting, paving, seating, railings and lighting

b. design, siting and materials used for the ventilation columns and control kiosks, and the zones within which these above ground structures may be located

c. design and materials used for the river wall around the foreshore structure and interception structure either side of Albert Bridge.

Environmental design measures

11.2.6 Figures illustrating the proposed development during operation are contained in a separate volume (Volume 16 Albert Embankment Foreshore Figures). Where photomontages have been prepared to assist the assessment of effects, these are referenced in the appropriate viewpoint in Section 11.6.

11.2.7 Measures which have been incorporated into the design of the proposed development include (refer to the proposed landscape plan, separate volume of figures – Section 1 and *Design Principles* report, Vol 1 Appendix B):

a. the new river walls to the interception chamber and shaft structures would be finished in high quality concrete

b. the use of materials in keeping with the surrounding townscape character for the public realm, including paving, seating, railings, lighting, and interpretive information materials

c. the top of the interception structure would be set below the springing point of the Grade II* listed Vauxhall Bridge

d. the integration of large hatches into the surrounding paving

e. the planting of new semi-mature trees on the foreshore structure

f. a commitment to a high quality design for the ventilation columns and control kiosks

g. the creation of planted inter-tidal terraces around the interception chamber to minimise its visibility.

11.3 Assessment methodology

Engagement

11.3.1 Volume 2 Environmental assessment methodology documents the overall engagement which has been undertaken in preparing the *Environmental Statement*. Specific comments relevant to this site for the assessment of townscape and visual effects are presented here.

11.3.2 Following the scoping process, the London Borough (LB) of Lambeth, neighbouring authorities (the LB of Wandsworth and Westminster City Council) and English Heritage have been consulted on the detailed approach to the townscape and visual assessment, including the number and location of viewpoints. All local authorities (March 2011, May 2011 and March 2011 respectively) and English Heritage (May 2011) have confirmed acceptance of the proposed viewpoints.

11.3.3 In March 2011, English Heritage and the Environment Agency were consulted on the scope of the townscape and visual and ecology assessments through a site visit. English Heritage provided feedback on the proposed design in particularly in relation to the design of the interception chamber. English Heritage also indicated their agreement of the proposed visual assessment viewpoints prior to their formal acceptance (described in para. 11.3.2 above).

11.3.4 The stakeholders were also consulted on proposed changes to the viewpoints following the preliminary assessment findings, including adding some new locations, removing some viewpoints and removing some viewpoints from the operational assessment. The Westminster City Council (September 2012) and LB of Wandsworth (October 2012) have confirmed acceptance of the proposed changes. The LB of Lambeth and English Heritage have not commented on the proposed changes.

11.3.5 The LB of Lambeth also requested that an assessment of the effects of operational phase lighting at night time was undertaken for visual receptors in the assessment area (June 2012). This has been undertaken and is reported in Section 11.6.

11.3.6 A description of how the on-site alternatives to the proposed approach have been considered and the main reasons why these alternatives have not been adopted is included in Section 3.6 of this volume.

Baseline

11.3.7 The baseline methodology follows the methodology described in Vol 2. In summary the following surveys have been undertaken to establish baseline data for this assessment:

a. Preliminary site visit to check the zone of theoretical visibility (ZTV), establish the extents of townscape character areas and identify locations for visual assessment viewpoints (October 2010)

b. Photographic survey of townscape character areas (August 2011)

c. Winter photographic surveys of the view from each visual assessment viewpoint (November 2011, December 2011 and February 2012)

d. Summer photographic surveys of the view from each visual assessment viewpoint considered in the operational assessment (August 2011)

e. Night time survey of the view from each visual assessment viewpoint considered in the operational assessment (July 2012)

f. Daytime verifiable photography (March 2011), night time verifiable photography (August 2012) and verifiable surveying (March 2011) for all viewpoints requiring a photomontage to be produced, as agreed with stakeholders (described in para. 11.3.2).

11.3.8 With specific reference to the Albert Embankment Foreshore site, baseline information on open space distribution and type, conservation areas, townscape character and protected views has been gathered through a review of:

a. The Core Strategy for the LB of Lambeth[2]

b. The Core Strategy for the LB of Wandsworth[3]

c. The Core Strategy for the City of Westminster[4]

d. Albert Embankment Conservation Area Designation Report, produced by the LB of Lambeth[5]

e. Pimlico, Churchill Gardens, Dolphin Square, Millbank and Smith Square Conservation Area General Information Leaflets, produced by the Westminster City Council[6].

Construction

11.3.9 The assessment methodology for the construction phase follows that described in Vol 2. Site specific variations are described below.

11.3.10 With reference to the Albert Embankment Foreshore site, the peak construction phase relevant to this topic would be during Site Year 2 of construction, when the shaft would be under construction. Cranes would be present at the site and material would be taken away by road. This has therefore been used as the assessment year for townscape and visual impacts. The intensity of construction activities would be similar during Site Year 3 of construction, during the secondary lining of the connection tunnel, involving the import of materials by road.

11.3.11 No assessment of effects on night time character is made for this site during construction on the basis that:

a. the site would generally only be lit in the early evening during winter, except for short durations of extended hours working and 24 hour working during the construction of the short connection tunnel

b. all site lighting would have minimal spill into the wider area due to the measures set out in the *CoCP (*see *CoCP Part A* section 4)

c. the surrounding area is lit in the early evening by street lighting and by light spill from surrounding buildings

d. visual receptors have limited sensitivity to additional lighting in the early evening.

11.3.12 The assessment area, defined using the methodology provided in Vol 2, is indicated in Vol 16 Figure 11.4.6 for townscape and Vol 16 Figure 11.4.7 for visual (see separate volume of figures). The scale of the townscape assessment area has been set by the maximum extents of all character areas located partially or entirely within the construction phase ZTV, except in those locations downstream of the site where the construction activity would in reality be obscured by Lambeth Bridge. The scale of the visual assessment area has been set by the maximum extent of the construction phase ZTV, except in those locations downstream of the site where the construction activity would in reality be obscured by Lambeth Bridge. All visual assessment viewpoints are located within the ZTV.

11.3.13 The construction assessment area for this site intersects with the assessment area for the proposed Thames Tideway Tunnel sites at Kirtling Street, Heathwall Pumping Station and Chelsea Embankment Foreshore, therefore likely significant effects on receptors arising from construction at all of these sites are included in this assessment.

11.3.14 For the construction base case for the assessment of effects arising from the proposed development at the Albert Embankment Foreshore site, it is assumed that the following developments within the assessment area would be complete and occupied by Site Year 2 of construction:

a. Riverwalk House, Millbank, comprising two new buildings up to 17 storeys high, located 160m northwest of the site on the opposite river bank, comprising residential with mixed uses on the ground floors

b. Hampton House mixed use development, comprising buildings between 13 and 27 storeys 230m northeast of the site

c. St Georges Wharf (Vauxhall Tower) residential development including a 50 storey tower, 200m south of the site

d. Market Towers mixed use development, comprising two new buildings (58 storeys and 43 storeys), approximately 300m southwest of the site

e. new 15 storey hotel at 10 Albert Embankment, approximately 350m northeast of the site

f. Parliament House mixed use development at 81 Black Prince Road, approximately 420m northeast of the site

g. Riverlight - a residential led mixed use development to the east of the Kirtling Street site

h. phases 1, 2 and 3 of the Battersea Power Station redevelopment, comprising the residential and mixed use plots to the west of the power station and the power station itself

i. Buildings B4, B5 and B6 of the New Covent Garden Market development, comprising mixed use plots to the south of the development, adjacent to the railway line

j. the US Embassy development, located 590m southwest.

k. buildings A02, A05, A09, A10 and A11 of the Embassy Gardens mixed use development surrounding the US Embassy development.

l. Vauxhall Sky Gardens mixed use development.

11.3.15 For the purposes of the cumulative effects assessment, it is assumed that the following developments would be under construction during Site Year 2 of construction at the Albert Embankment Foreshore site:

a. buildings A01, A03, A04 and A07 of the Embassy Gardens development

b. phase 4 and parts of phase 5 and 6 of the Battersea Power Station redevelopment.

11.3.16 The assessment of construction effects also considers the extent to which the assessment findings would be likely to be materially different, should the programme for the Thames Tideway Tunnel project be delayed by approximately one year.

Operation

11.3.17 The assessment methodology for the operational phase follows that described in Vol 2. Any site-specific variations are described below.

11.3.18 Two daytime verifiable photomontages have been prepared for this site to assist the assessment of operational effects during the day. These are shown in Vol 16 Figure 11.6.1 and Vol 16 Figure 11.6.2 (see separate volume of figures). One night time verifiable photomontage has been prepared for this site to assist the assessment of operational visual effects during the night. This is shown in Vol 16 Figure 11.6.3 (see separate volume of figures).

11.3.19 The operational phase assessment has been undertaken for Year 1 of operation and Year 15 of operation.

11.3.20 The assessment area, defined using the methodology provided in Vol 2, is indicated in Vol 16 Figure 11.4.6 for townscape and Vol 16 Figure 11.4.7 for visual (see separate volume of figures). The scale of the townscape assessment area has been set by the maximum extents of all character areas located partially or entirely within the operational phase ZTV, except in those locations downstream of the site where the proposed development would in reality be obscured by Lambeth Bridge. The scale of the visual assessment area has been set by the maximum extent of the operational phase ZTV, except in those locations downstream of the site where the proposed development would in reality be obscured by Lambeth Bridge. All visual assessment viewpoints are located within this.

11.3.21 The operational assessment area for this site intersects with the assessment area for the proposed Thames Tideway Tunnel sites at Kirtling Street and Heathwall Pumping Station, therefore likely significant effects on receptors arising from the proposed development at all of these sites are assessed in this assessment.

11.3.22 In terms of the operational base case for the assessment of effects on Albert Embankment Foreshore, it is assumed that the following developments within the assessment area would be complete and occupied by Year 1 of operation:

a. Phase 4, parts of phase 5 and phase 6 of the Battersea Power Station redevelopment, comprising the mixed plots to the southeast of the power station
b. Buildings B1, B2, B3 and the site entrance of the New Covent Garden Market development, comprising mixed use plots to the north of the development adjacent to Nine Elms Lane
c. All plots in the Embassy Gardens development would be fully complete and occupied
d. Plots A, B, C and D of the Post Office Depot mixed use redevelopment, comprising plots to the west of the development
e. Vauxhall Square development would be fully complete and operational

11.3.23 For the purposes of the Year 15 assessment, it is assumed that all of the above developments would be fully complete and occupied by Year 15 of operation.

11.3.24 As detailed in the site development schedule (Vol 16 Appendix N) no schemes have been identified within 1km of the site which meet the criteria for inclusion in the cumulative assessment. Therefore no assessment of cumulative effects has been undertaken for effects on Albert Embankment Foreshore in the operational phase.

11.3.25 As with construction (para. 11.3.16), the assessment of operational effects also considers the extent to which the assessment findings would be likely to be materially different, should the programme for the Thames Tideway Tunnel project be delayed by approximately one year.

Assumptions and limitations

11.3.26 The assumptions and limitations associated with this assessment are presented in Vol 2. Site specific assumptions and limitations are detailed below.

Assumptions

11.3.27 For the purposes of the construction phase assessment, it is assumed that the construction activities and plant, site hoardings, welfare facilities and access points are in the location shown on the Construction phase two plan (see separate volume of figures – Section 1). The assessment of effects would be no worse if these elements of the proposed development were in different locations within the maximum extent of working area shown on the Construction phase plans (see separate volume of figures – Section 1), with the permanent structures under construction located within the zones shown on the Site works parameter plan (see separate volume of figures – Section 1).

11.3.28 For the purposes of the operational phase assessment, it is assumed that the above ground structures are in the location shown on the illustrative landscape plan (see separate volume of figures – Section 1). The assessment of effects would be no worse if these elements of the proposed development were in different locations within the zones (shown on the Site works parameter plan, see separate volume of figure – Section 1).

Limitations

11.3.29 There are no limitations specific to the assessment of this site.

11.4 Baseline conditions

11.4.1 The following section sets out the baseline conditions for the townscape and visual assessment within and around the site as follows:

a. Information on the physical elements that make up the overall townscape character of the assessment area (topography, land use, development patterns, vegetation, open space and transport routes), which inform the identification of townscape character areas. These form the receptors for the townscape assessment.

b. Information on the townscape character (including setting), condition, tranquillity, value and sensitivity of the site and each townscape character area.

c. Information on the nature of the existing views towards the site from all visual assessment viewpoints, during winter and summer, and during both daytime and night time where relevant. This is ordered beginning with the most sensitive receptors through to the least sensitive.

d. Future baseline conditions (base case) are also described.

Current baseline

Townscape baseline

Physical elements

11.4.2 The physical elements of the townscape in the assessment area are described below. The assessment area includes a number of conservation areas, which are shown on Vol 16 Figure 11.4.1 (see separate volume of figures).

Topography

11.4.3 The site is located on a relatively flat plateau along Albert Embankment. There are no notable topographic features in the wider assessment area.

Land use

11.4.4 In the vicinity of the site, the south bank of the river is characterised by commercial uses along the railway line between Vauxhall and London Waterloo mainline stations, with the exception of Peninsula Heights and the extensive St George's Wharf residential development south of Vauxhall Bridge. Further away from the river, land use is predominantly residential.

11.4.5 On the north bank of the river, land use is predominantly residential apart from some leisure and tourism related uses close to the river, such as Tate Britain art gallery and the Chelsea College of Art & Design to the northwest of the site.

Development patterns and scale

11.4.6 Vol 16 Figure 11.4.2 (see separate volume of figures) illustrates the pattern and scale of development and building heights within the assessment area.

11.4.7 Within the assessment area, the south bank river frontage is characterised by dense blocks of buildings with large footprints, many of which are above 40m high. Buildings are typically orientated towards the river and back onto the railway line between Vauxhall and London Waterloo mainline stations. Albert Embankment is characterised by a relatively narrow pedestrian route (the Thames Path), partially along Albert Embankment road and partially in front of commercial and residential premises. The Vauxhall Cross building adjacent to the site forms a dominant building along the riverfront, partially encroaching into the river channel.

11.4.8 On the north bank of the river, opposite the site, residential properties are arranged in a grid formation, and are dominated by two to four storey terraces with intermittent high-rise developments.

Vegetation patterns and extents

11.4.9 Vol 16 Figure 11.4.3 (see separate volume of figures) illustrates the pattern and extent of vegetation, including tree cover, within the assessment area.

11.4.10 South of the river, street trees are uncommon within the assessment area, with the exception of some along the river frontage. Vegetation on the southern bank of the river is concentrated into public and private open spaces, notably Spring Gardens and Albert Embankment Gardens, including residential rear gardens.

11.4.11 Street trees are a more important element of the character of the townscape on the northern bank, with numerous roads densely planted with mature avenues. Mature tree planting is also a key characteristic of the public and private open spaces throughout the area.

11.4.12 A number of trees in the assessment area are protected by Tree Preservation Orders (TPOs), and trees within conservation areas on both sides of the river are indirectly protected.

Open space distribution and type

11.4.13 Vol 16 Figure 11.4.4 (see separate volume of figures) illustrates the distribution of different open space types within the assessment area, indicating all relevant statutory, non-statutory and local plan designations.

11.4.14 Public open spaces within the assessment area are broadly limited to Albert Embankment on the south bank (designated as a Green Chain) and Millbank on the north bank. There are also a number of large private and semi-private spaces throughout the assessment area. The key public and private open spaces are described in more detail in Vol 16 Table 11.4.1 below.

Vol 16 Table 11.4.1 Townscape – open space type and distribution

Open space	Distance from site	Character summary
St John's Gardens	700m north (north of river)	Small private square planted with mature London plane trees that dominate the space, forming a dense canopy in summer. Designated Open Space in the City of Westminster's UDP.
Albert Embankment (South Bank)	0m	Linear hard surfaced public route along the south bank of the river, designated as a Green Chain.
Millbank	200m west (north of river)	Small public open space with a formal terraced grass area and scattered trees along the western boundary. Located in Millbank Conservation Area.

Transport routes

11.4.15 Vol 16 Figure 11.4.5 (see separate volume of figures) illustrates the transport network within the assessment area, including cycleways, footpaths and Public Rights of Way.

11.4.16 The site is located close to Albert Embankment and Vauxhall Bridge, both of which are characterised by high levels of traffic. The wider area on the south bank of the river is dominated by transport infrastructure, including the railway line running north-south, connecting London Waterloo and Vauxhall mainline stations.

11.4.17 The north bank of the river is characterised by Millbank running along the river frontage, dominated by relatively heavy traffic. The remainder of the area is predominantly characterised by quiet residential streets.

11.4.18 The Thames Path runs along both banks of the river, although the route is much wider and dedicated to pedestrians on the south bank.

Site character assessment

11.4.19 The site is located within Albert Embankment Conservation Area in the LB of Lambeth, immediately downstream of the Grade II* listed Vauxhall Bridge. The site is located partially on a stretch of pavement along Albert Embankment and partially within the river. The combined sewer overflow (CSO) interception works are located underneath Vauxhall Bridge.

11.4.20 Within the site boundary, the river wall is set slightly further back from the river wall line further downstream, leading to Lack's Dock, an inlet alongside Vauxhall Cross. The frontage is characterised by regularly spaced lamp standards. Upstream of the main site, the river frontage is dominated by Vauxhall Cross, which includes a solidly constructed river wall and distinctive large green railings, which are somewhat out of character with the surrounding townscape. This stretch is lined with semi-mature trees. The foreshore is wide and accessible to the public, within the site boundary area. Lack's Dock is used by London Duck Tours, a recreational / tourist river boat attraction.

11.4.21 The character of the site is illustrated by Vol 16 Plate 11.4.1 and the components of the site are described in more detail in Vol 16 Table 11.4.2.

Vol 16 Plate 11.4.1 The character of the site

Date taken: 2 August 2011. 18mm lens.

Vol 16 Table 11.4.2 Townscape – site components

ID	Component	Description	Condition
01	River wall	Brick and stone river wall of varying ages, different in character to listed Sir Joseph Bazalgette stretches further downstream (outside the site) and the wall in front of Vauxhall Cross and St Georges Wharf development.	Poor condition
02	Thames Path	Asphalt surfaced public route, connecting with a short landscaped esplanade in front of the Vauxhall Cross.	Fair condition
03	Handrailing and lighting columns	Green steel handrail along the river in front of Camelford House and the north side of Lack's Dock.	Fair condition
04	Trees and shrubs	Trees and numerous shrubs located in a line on the northern side of Lack's Dock. Six semi-mature trees and various shrubs planted at either end of Vauxhall	Fair condition

ID	Component	Description	Condition
		Cross.	
05	Raised planters	Raised planters located at both ends of Lack’s Dock.	Fair condition
06	Concrete wall	Concrete wall located north of Lack’s Dock	Poor condition
07	Lack’s Dock boundary wall	Boundary wall located north of Lack’s Dock	Poor condition
08	Thames Path boundary wall	Boundary wall adjacent to Thames Path and Camelford House.	Fair condition
09	Ramp	Ramp to basement car park near Camelford House.	Fair condition
10	Security kiosk	Security kiosk to Lack’s Dock.	Fair condition

11.4.22 A baseline description of Albert Embankment Conservation Area as a heritage asset is provided in Section 7.4 of this volume.

11.4.23 The condition of the townscape within the site is poor to fair, with some components in need of repair and maintenance.

11.4.24 The site’s location close to the interchange of Albert Embankment and Vauxhall Bridge, dominated by heavy traffic, means the site has limited tranquillity. The river is also heavily used, further reducing levels of tranquillity.

11.4.25 The site is located within a regionally valued stretch of the River Thames, providing the setting to a number of conservation areas on both sides of the river and experienced by many residents and visitors by virtue of recreational tours such as London Duck Tours and attractions such as Tate Britain on the opposite river bank.

11.4.26 Due to the poor to fair condition and low levels of tranquillity, set against the regional value of the townscape, the site has a medium sensitivity to change.

Townscape character assessment

11.4.27 The townscape character areas surrounding the site are identified in Vol 16 Figure 11.4.6 (see separate volume of figures). Townscape character areas are ordered beginning with the river reaches, then to the north of the site and continuing around the site in a clockwise direction. Each area is described below.

River Thames – Nine Elms Reach TCA

11.4.28 This reach of the river extends from Chelsea Bridge in the west to Vauxhall Bridge in the east, adjacent to the site. The reach is largely characterised by residential development, set against the changing character of the area in the vicinity of Battersea Power Station, which is undergoing redevelopment. The character of this area is illustrated by Vol 16 Plate 11.4.2.

Vol 16 Plate 11.4.2 River Thames – Nine Elms Reach TCA

Date taken: 2 August 2011. 18mm lens.

11.4.29 The river, within the assessment area, is characterised by a varying frontage with different river wall characters and numerous piers, jetties and small inlets. Both banks have a relatively wide area of foreshore at low tide.

11.4.30 The river walls and structures are relatively well maintained. The overall townscape condition is fair.

11.4.31 Despite the residential character of the river frontage, the presence of heavy industries in the immediate area (including a cement batching plant and a waste transfer station close to Battersea Power Station), which in turn generate industrial river transport, means the reach has a moderate level of tranquillity.

11.4.32 The reach is a regionally valued stretch of the river, forming the backdrop to a number of conservation areas on both sides of the river, in addition to Battersea Power Station; one of the highest profile regeneration projects in London.

11.4.33 Due to the fair condition and moderate levels of tranquillity, this character area has a medium sensitivity to change.

River Thames – Vauxhall and Pimlico Reach TCA

11.4.34 This reach of the river extends from Vauxhall Bridge in the west to Lambeth Bridge in the east. The reach is largely characterised by a mixed use riverfront, comprising commercial, residential and institutional uses. The character of this area is illustrated by Vol 16 Plate 11.4.3.

Vol 16 Plate 11.4.3 River Thames – Vauxhall and Pimlico Reach TCA

Date taken: 2 August 2011. 18mm lens.

11.4.35 The river is characterised by a relatively consistent sweep around the bend of the river, with only two piers forming incursions, and Lack's Dock forming an inlet close to the site. Both banks have a relatively wide area of foreshore at low tide.

11.4.36 The river walls and structures are well maintained. The overall townscape condition is good.

11.4.37 Despite the residential character of part of the river frontage, the presence of commercial uses and high-rise development means the reach has a moderate level of tranquillity.

11.4.38 The reach is a regionally valued stretch of the river, forming the setting to a number of conservation areas along both sides of the river.

11.4.39 Due to the good condition and regional value of the townscape, this character area has a high sensitivity to change.

Albert Embankment Commercial TCA

11.4.40 This area comprises predominantly commercial uses and includes part of the Albert Embankment Conservation Area designated by the LB of Lambeth. The area is characterised by large high-rise commercial premises, including Vauxhall Cross and Camelford House (neither are listed) the latter representing the tallest building in this character area at 18 storeys. The buildings are orientated towards the river and back onto the railway line between Vauxhall and London Waterloo mainline stations. The area has a lack of street trees apart from in front of the post-modern style Vauxhall Cross building. The river frontage forms a strong, consistent sweep, interrupted by the inlet at Lack's Dock and the encroachment of the Vauxhall Cross building. The character of this area is illustrated by Vol 16 Plate 11.4.4.

Vol 16 Plate 11.4.4 Albert Embankment Commercial TCA

Date taken: 2 August 2011. 18mm lens.

11.4.41 A baseline description of Albert Embankment Conservation Area and Vauxhall Cross as heritage assets is provided in Section 7.4 of this volume.

11.4.42 The buildings and public realm within the area are fairly well maintained, although some components are in need of repair and replacement. The overall townscape condition is fair.

11.4.43 Tranquillity within the area is limited by the commercial land use, presence of high levels of vehicular traffic, the busy railway line nearby and the lack of street trees or other vegetation.

11.4.44 The character area is located adjacent to a regionally valued stretch of the river, with the Vauxhall Cross building in particular contributing to a well-recognised London panorama along the river. The area is also experienced by many residents and visitors by virtue of recreational tours such as London Duck Tours and attractions such as Tate Britain on the opposite river bank.

11.4.45 Due to the fair condition of the townscape and low levels of tranquillity, set against the regional value of the townscape, this character area has a medium sensitivity to change.

St George's Wharf Residential TCA

11.4.46 St George's Wharf Residential is characterised by a recent residential development comprising five 22 storey towers orientated towards the river and a new 50 storey tower currently under construction. These buildings are set amongst extensive semi-private open space. The character area also incorporates Market Towers, a 23 storey commercial tower. The character of this area is illustrated by Vol 16 Plate 11.4.5.

Vol 16 Plate 11.4.5 St George's Wharf Residential TCA

Date taken: 2 August 2011. 18mm lens.

11.4.47 The buildings and public realm within the area are well maintained. The overall townscape condition is good.

11.4.48 The area has moderate levels of tranquillity by virtue of the residential character and density of open space amongst the residential blocks, slightly moderated by the presence of the busy Nine Elms Lane running through the character area.

11.4.49 The high rise riverfront development is likely to be locally valued by the residents that live there. Due to the good condition, moderate levels of tranquillity and local value of the townscape, this area has a medium sensitivity to change.

Nine Elms Lane Residential TCA

11.4.50 This character area comprises a narrow band of residential apartments along the riverfront, bounded to the south by Nine Elms Lane and the industrial and commercial units further inland. The residential buildings are brick built and seven to nine storeys high. The Thames Path runs along the river, connecting small areas of public open space at either end of the area, characterised by amenity grassland and scattered mature and semi-mature trees. The character of this area is illustrated by Vol 16 Plate 11.4.6.

Vol 16 Plate 11.4.6 Nine Elms Lane Residential TCA

Date taken: 2 August 2011. 18mm lens.

11.4.51 The buildings and public realm within the area are well maintained and the overall townscape condition is good.

11.4.52 Tranquillity within the area is limited by pedestrian movements along the riverside path and the presence of Nine Elms Lane, although this is partially moderated by the presence of green open spaces and the residential character of the area. Therefore, the area has a moderate level of tranquillity.

11.4.53 The area is likely to be locally valued by residents within the character area, but has limited townscape value in the wider area.

11.4.54 Due to the good condition and local value of the townscape, and the moderate levels of tranquillity, this area has a medium sensitivity to change.

Residential Waterfront - West TCA

11.4.55 This area is characterised by four to eight storey modern residential apartments, alongside a 20 storey residential tower at the corner of Grosvenor Road and Vauxhall Bridge Road, and a 13 storey commercial tower north of Vauxhall Bridge Road. The development pattern is orientated towards the river and further characterised by areas of private and communal open space, with scattered mature trees. The Thames Path follows the river, in front of the residential developments. The character of this area is illustrated by Vol 16 Plate 11.4.7.

Vol 16 Plate 11.4.7 Residential Waterfront - West TCA

Date taken: 2 August 2011. 18mm lens.

11.4.56 The buildings and public realm within the area are well maintained. The overall townscape condition is good.

11.4.57 Despite the presence of busy traffic along Grosvenor Road and Vauxhall Bridge Road, the townscape has moderate levels of tranquillity due to the residential character and abundance of open space and mature tree planting.

11.4.58 The character is located adjacent to a regionally valued stretch of the river, currently undergoing significant change. The high rise riverfront development is a particularly distinctive contribution to the wider riverside setting. The area is also experienced by many residents and visitors by virtue of recreational tours such as London Duck Tours and attractions such as Tate Britain.

11.4.59 Due to the good condition and regional value of the townscape, this area has a high sensitivity to change.

Westminster Residential TCA

11.4.60 This area is dominated by residential uses and incorporates parts of Millbank and Smith Square Conservation Areas. The character of this area is illustrated by Vol 16 Plate 11.4.8.

Vol 16 Plate 11.4.8 Westminster Residential TCA

Date taken: 2 August 2011. 18mm lens.

11.4.61 The area is characterised by residential uses, dominated by three to seven storey Edwardian and post World War I red and yellow brick buildings organised on a grid formation. In addition to Vincent Square, the area is characterised by intermittent small private, semi-private and public open spaces. Street trees are present across most of the area, providing an overall green character to the area. The area is largely inward looking in character, focused on public and private spaces internal to the area, although the river frontage is heavily influenced by the character of the river and opposite bank.

11.4.62 The buildings and public realm within the area are well maintained. The overall townscape condition is good.

11.4.63 Despite the presence of some busy roads through the area, the townscape has moderate levels of tranquillity due to the residential character and inward looking nature of the area.

11.4.64 The townscape of the character area is valued at the borough level, by virtue of the conservation area designations.

11.4.65 Due to the good condition and borough level value of the townscape, this character area has a high sensitivity to change.

Millbank Conservation Area - Institutional TCA

11.4.66 This area comprises part of Millbank Conservation Area characterised by institutional uses, including Tate Britain art gallery, the Royal Army Medical College and the former Queen Alexandra Military Hospital. This area is divided from the rest of the character area (dominated by residential uses similar in character to the surrounding areas and incorporated into Westminster Residential TCA) by John Islip Street.

Millbank Embankment is characterised by a pedestrian route alongside the busy road, with Grade II listed lamp standards and mature London plane trees along the frontage. The character area is set directly adjacent to the river. The character of this area is illustrated by Vol 16 Plate 11.4.9.

Vol 16 Plate 11.4.9 Millbank Conservation Area - Institutional TCA

Date taken: 2 August 2011. 18mm lens.

11.4.67 A baseline description of Millbank Conservation Area as a heritage asset is provided in Section 7.4 of this volume.

11.4.68 The buildings and public realm within the area are well maintained. The overall townscape condition is good.

11.4.69 Tranquillity within the area is limited by the presence of high levels of vehicular traffic and pedestrian movements.

11.4.70 The character area is located within a regionally valued stretch of the river that is currently undergoing significant change. The high rise riverfront development is a particularly distinctive contribution to the wider riverside setting. The area is also experienced by many residents and visitors by virtue of recreational tours such as London Duck Tours and attractions such as Tate Britain art gallery.

11.4.71 Due to the good condition and regional value of the townscape, this area has a high sensitivity to change.

Visual baseline

11.4.72 Vol 16 Figure 11.4.7 (see separate volume of figures) indicates the location of viewpoints referenced below. All residential and recreational receptors have a high sensitivity to change. For each viewpoint, the first part of the baseline description relates to the view during winter, the second part relates to the summer view for viewpoints included in the operational assessment and the final part relates to the view at night time, again for viewpoints included in the operational assessment.

Residential

11.4.73 Residential receptors have a high sensitivity to change, as attention is often focused on the townscape surrounding the property rather than on another focused activity (as would be the case in predominantly employment or industrial areas). The visual baseline for residential receptors (represented by a series of viewpoints, agreed with consultees) is described below.

Viewpoint 1.1: View northeast and southwest from residences on Nine Elms Lane

11.4.74 This viewpoint is representative of the typical view from residential properties on the south bank of the river along Nine Elms Lane.

Vol 16 Plate 11.4.10 Viewpoint 1.1: winter view towards Albert Embankment Foreshore (northeast)

Date taken: 21 November 2011. 18mm lens.

11.4.75 The view (illustrated in Vol 16 Plate 11.4.10) is focused along the south bank of the river. Residences along Nine Elms Lane form the foreground of the view, Vauxhall Tower (under construction) and St George's Wharf form the middle ground, and Vauxhall Bridge and commercial buildings along Albert Embankment beyond form the background of the view. Views of the Albert Embankment Foreshore site are largely obscured by Vauxhall Bridge.

11.4.76 This viewpoint is also located within the ZTV of the proposed Thames Tideway Tunnel sites at Heathwall Pumping Station and Kirtling Street (refer to para.11.3.13).

Vol 16 Plate 11.4.11 Viewpoint 1.1: winter view towards Heathwall Pumping Station and Kirtling Street (southwest)

Date taken: 9 December 2011. 35mm lens.

11.4.77 The view (illustrated in Vol 16 Plate 11.4.11) is an open panorama up the river, and is focused on Battersea Power Station. Views of the parts of the Heathwall Pumping Station and Kirtling Street sites located on the foreshore are visible from this location, although the remainder of the sites further inland are obscured.

Viewpoint 1.2: View northeast and southwest from residences on Grosvenor Road opposite St George's Square

11.4.78 This viewpoint is representative of the typical oblique view from residential properties adjacent to the Thames Path on the north bank of the river, on Grosvenor Road opposite St George's Square.

Vol 16 Plate 11.4.12 Viewpoint 1.2: winter view towards Albert Embankment Foreshore (northeast)

Date taken: 15 February 2012. 50mm lens.

11.4.79 The view (illustrated in Vol 16 Plate 11.4.12) is an open panorama over the river, focused towards the St George's Wharf development and Vauxhall Bridge, which form dominant components of the background of the view. Views of the Albert Embankment Foreshore site are largely obscured by Vauxhall Bridge, apart from the CSO interception site to the west of the bridge, which is directly visible.

11.4.80 This viewpoint is also located within the ZTV of the proposed Thames Tideway Tunnel sites at Heathwall Pumping Station and Kirtling Street (refer to para. 11.3.13).

Vol 16 Plate 11.4.13 Viewpoint 1.2: winter view towards Heathwall Pumping Station and Kirtling Street (southwest)

Date taken: 9 December 2011. 18mm lens.

11.4.81 The view (illustrated in Vol 16 Plate 11.4.13) is an open panorama across the river towards Battersea Power Station (far right of the view illustrated). The view is characterised by industrial buildings along the south bank of the river. The existing Heathwall pumping station is visible set amongst other industrial buildings similar in character. Views of the Kirtling Street and Heathwall Pumping Station sites from this viewpoint are partially obscured by an existing pier in the foreground of the view.

Viewpoint 1.3: View northeast and southwest from residences on Grosvenor Road near Balvaird Place

11.4.82 This viewpoint is representative of the typical oblique view from residential properties adjacent to the Thames Path on the north bank of the river, on Grosvenor Road, near Balvaird Place.

Vol 16 Plate 11.4.14 Viewpoint 1.3: winter view towards Albert Embankment Foreshore (northeast)

Date taken: 9 December 2011. 35mm lens.

11.4.83 The view (illustrated in Vol 16 Plate 11.4.14) is an open panorama over the river, focused towards the St George's Wharf development and Vauxhall Bridge, which form dominant components of the background of the view. Views of the Albert Embankment Foreshore site are largely obscured by Vauxhall Bridge, apart from the part of the site to the west of the bridge which is directly visible.

11.4.84 This viewpoint is also located within the ZTV of the proposed Thames Tideway Tunnel sites at Heathwall Pumping Station and Kirtling Street (refer to para. 11.3.13).

Vol 16 Plate 11.4.15 Viewpoint 1.3: winter view towards Heathwall Pumping Station and Kirtling Street (southwest)

Date taken: 9 December 2011. 35mm lens.

11.4.85 The view (illustrated in Vol 16 Plate 11.4.15) is an open panorama over the river towards Battersea Power Station (just beyond the field of view illustrated). The view is characterised by industrial buildings along the south bank of the river, in addition to residential premises along Nine Elms Lane in the foreground of the view (far left of the image). The existing Heathwall pumping station is visible set amongst other industrial buildings similar in character. Views of the Kirtling Street and Heathwall Pumping Station and sites, partially located on the foreshore, are unobstructed from this viewpoint.

Viewpoint 1.4: View southeast from residences at the junction of Ponsonby Place and Causton Street

11.4.86 This viewpoint is representative of the typical view from residential properties close to the junction of Ponsonby Place and Causton Street, and is recorded as a local view.

Vol 16 Plate 11.4.16 Viewpoint 1.4: winter view

Date taken: 21 November 2011. 18mm lens.

11.4.87 The linear view (illustrated in Vol 16 Plate 11.4.16) along Ponsonby Place to the river is framed by residential development. The background of the view is characterised by Camelford House, directly behind the site. Views towards the site are partially obscured by trees lining the north bank of the river.

Recreational

11.4.88 Recreational receptors (apart from those engaged in active sports) have a high sensitivity to change, as attention is focused on enjoyment of the townscape. Tourists engaged in activities whereby attention is focused on the surrounding townscape also have a high sensitivity to change. The visual baseline in respect of recreational receptors, including tourists, is discussed below.

Viewpoint 2.1: View south from Lambeth Bridge

11.4.89 This viewpoint is positioned in the same location as a River Prospect in the London View Management Framework (LVMF) (Lambeth Bridge viewing location 19A.1), but focuses up the river rather than taking the designated view towards the Houses of Parliament. The viewpoint is representative of the typical view that pedestrians experience while crossing Lambeth Bridge.

Vol 16 Plate 11.4.17 Viewpoint 2.1: winter view

Date taken: 21 November 2011. 18mm lens.

11.4.90 The linear view (illustrated in Vol 16 Plate 11.4.17) up the river is focused on Vauxhall Bridge in the background of the view. To the south, the view is framed by residential and commercial premises, including Camelford House and the Vauxhall Cross building close to the site. To the north, the view is framed by the avenue of mature London plane trees along the north bank. Views of the site are unobstructed from this location.

Vol 16 Plate 11.4.18 Viewpoint 2.1: summer view

Date taken: 2 August 2011. 18mm lens.

11.4.91 In summer, the view towards the site (illustrated in Vol 16 Plate 11.4.18) is largely unchanged.

11.4.92 At night, the view is characterised by light spill from buildings and vehicles, in addition to street lighting and columns along the Thames Path, on the south bank of the river. However, the unlit expanse of river forms the key component of the foreground view at night.

Viewpoint 2.2: View south from the Thames Path at the southern end of Lambeth Bridge

11.4.93 This viewpoint is representative of the typical view that pedestrians experience while walking south along the Thames Path, close to Lambeth Bridge.

Vol 16 Plate 11.4.19 Viewpoint 2.2: winter view

Date taken: 21 November 2011. 18mm lens.

11.4.94 The linear view (illustrated in Vol 16 Plate 11.4.19) up the river is focused on Vauxhall Bridge, which forms the background of the view. To the south, the view is framed by residential and commercial premises, including glimpsed views of Camelford House and the Vauxhall Cross building close to the site. To the north, the view is framed by the avenue of mature London plane trees along the north bank. Views of the site are largely unobstructed from this location, apart from by a river pier in the foreground of the view.

Viewpoint 2.3: View southwest from the Thames Path opposite Park Plaza

11.4.95 This viewpoint is representative of the typical view pedestrians experience while walking south along the Thames Path, outside Park Plaza.

Vol 16 Plate 11.4.20 Viewpoint 2.3: winter view

Date taken: 21 November 2011. 18mm lens.

11.4.96 The linear view (illustrated in Vol 16 Plate 11.4.20) up the river is focused on Vauxhall Bridge which forms the background of the view. To the south, the view is framed by residential and commercial premises, including glimpsed views of Camelford House and Vauxhall Cross close to the site. On the north bank, commercial properties are visible in the background of the view. Views of the site are largely unobstructed from this location, although the site is set slightly back from the line of the river wall, close to Lack's Dock.

Vol 16 Plate 11.4.21 Viewpoint 2.3: summer view

Date taken: 2 August 2011. 18mm lens.

11.4.97 In summer, foreground trees along the Thames Path partially screen views towards the site (illustrated in Vol 16 Plate 11.4.21).

11.4.98 At night, the foreground of the view is lit by street lighting along the Thames Path, in addition to light spill from vehicles and buildings along the southern bank.

Viewpoint 2.4: View southwest from the Thames Path outside Peninsula Heights

11.4.99 This viewpoint is representative of the typical view pedestrians experience while walking south along the Thames Path, outside the northern end of Peninsula Heights.

Vol 16 Plate 11.4.22 Viewpoint 2.4: winter view

Date taken: 21 November 2011. 18mm lens.

11.4.100 The linear view (illustrated in Vol 16 Plate 11.4.22) up the river is focused on Vauxhall Bridge, which forms the middle ground of the view, adjacent to distinctive residential blocks in the St George's Wharf development. Battersea Power Station forms the background of the view. The view towards the site is framed by riverfront development, including Camelford House and Vauxhall Cross. Views of the site are largely unobstructed from this location, although the site is set slightly back from the line of the river wall, close to Lack's Dock.

Vol 16 Plate 11.4.23 Viewpoint 2.4: summer view

Date taken: 2 August 2011. 18mm lens.

11.4.101 In summer, the view towards the site is largely unchanged (see Vol 16 Plate 11.4.23).

11.4.102 At night, the foreground of the view is lit by street lighting along the Thames Path, in addition to light spill from vehicles and buildings along the southern bank. St George's Wharf forms a well lit backdrop to the view.

Viewpoint 2.5: View northeast from the southern end of Vauxhall Bridge

11.4.103 This viewpoint is representative of the typical view pedestrians experience while crossing Vauxhall Bridge, and is located at the southern end of the bridge.

Vol 16 Plate 11.4.24 Viewpoint 2.5: winter view

Date taken: 21 November 2011. 18mm lens.

11.4.104 The linear view (illustrated in Vol 16 Plate 11.4.24) down the river is focused on Lambeth Bridge, which forms the background of the view. The foreground of the view towards the site is dominated by Camelford House and Vauxhall Cross. Views of the site are unobstructed from this location.

Vol 16 Plate 11.4.25 Viewpoint 2.5: summer view

Date taken: 2 August 2011. 18mm lens.

11.4.105 In summer, the view towards the site is largely unchanged (see Vol 16 Plate 11.4.25).

11.4.106 At night, the view is characterised by light spill from buildings and vehicles, in addition to street lighting and columns along the Thames Path, on the south bank of the river. However, the unlit expanse of river forms the key component of the foreground view at night.

11.4.107 A baseline description of the Grade II* listed Vauxhall Bridge as a heritage asset is provided in Section 7.4 of this volume.

Viewpoint 2.6: View northeast and southwest from the Thames Path south of St George's Wharf

11.4.108 This viewpoint is representative of the view pedestrians experience while walking north along the Thames Path, to the south of the St George's Wharf riverfront development.

Vol 16 Plate 11.4.26 Viewpoint 2.6: winter view towards Albert Embankment Foreshore (northeast)

Date taken: 21 November 2011. 18mm lens.

11.4.109 The view (illustrated in Vol 16 Plate 11.4.26) is characterised by an open panorama over the river towards Vauxhall Bridge, visible in the middle ground of the view. The view towards the Albert Embankment Foreshore site is framed by the St George's Wharf development, Vauxhall Cross and Camelford House. Views towards the site are largely obscured by Vauxhall Bridge.

Vol 16 Plate 11.4.27 Viewpoint 2.6: summer view towards Albert Embankment Foreshore (northeast)

Date taken: 2 August 2011. 18mm lens.

11.4.110 In summer, the view towards the Albert Embankment Foreshore site (illustrated in Vol 16 Plate 11.4.27) is largely unchanged.

11.4.111 At night, the foreground of the view is lit by street lighting along the Thames Path, in addition to light spill from buildings (including residences in St George's Wharf, along the southern bank.

11.4.112 This viewpoint is also located within the ZTV of the proposed Thames Tideway Tunnel sites at Heathwall Pumping Station and Kirtling Street.

Vol 16 Plate 11.4.28 Viewpoint 2.6: winter view towards Heathwall Pumping Station and Kirtling Street (southwest)

Date taken: 9 December 2011. 35mm lens.

11.4.113 The view (illustrated in Vol 16 Plate 11.4.28) is an open panorama over the river, focused on Battersea Power Station in the background. The view is also focused on residential properties along Nine Elms Lane which are set beyond the foreground of the river frontage of St George's Wharf. The existing Heathwall pumping station is visible set amongst other industrial buildings similar in character. Views of the Kirtling Street and Heathwall Pumping Station sites are partially obscured, although views of the foreshore parts of the sites are largely unobstructed.

Vol 16 Plate 11.4.29 Viewpoint 2.6: summer view towards Heathwall Pumping Station and Kirtling Street (southwest)

Date taken: 8 August 2011. 35mm lens.

11.4.114 In summer, the view towards the Heathwall Pumping Station and Kirtling Street sites (illustrated in Vol 16 Plate 11.4.29) is largely unchanged.

Viewpoint 2.7: View east from the northern end of Vauxhall Bridge

11.4.115 This viewpoint is representative of the typical view pedestrians experience while crossing Vauxhall Bridge, and is located at the northern end of the bridge.

Vol 16 Plate 11.4.30 Viewpoint 2.7: winter view

Date taken: 21 November 2011. 18mm lens.

11.4.116 The view from this location (illustrated in Vol 16 Plate 11.4.30) is focused on the distinctive Vauxhall Cross building and Camelford House, immediately behind the site. Views of the site are unobstructed from this location.

Vol 16 Plate 11.4.31 Viewpoint 2.7: summer view

Date taken: 2 August 2011. 18mm lens.

11.4.117 In summer, the view towards the site (illustrated in Vol 16 Plate 11.4.31) is largely unchanged.

11.4.118 At night, the view is characterised by light spill from buildings, in addition to street lighting along the Thames Path, on the south bank of the river. However, the unlit expanse of river forms the key component of the foreground view at night.

Viewpoint 2.8: View east from the Thames Path at an open space along Millbank

11.4.119 This viewpoint is representative of the typical view recreational users of the open space adjacent to Millbank and close to Vauxhall Bridge experience while looking across the river.

Vol 16 Plate 11.4.32 Viewpoint 2.8: winter view

Date taken: 21 November 2011. 18mm lens.

11.4.120 The view from this location (illustrated in Vol 16 Plate 11.4.32) is characterised by the commercial and residential buildings lining the south bank of the river, including (from left to right) Camelford House, Vauxhall Cross and St George's Wharf. Lambeth Bridge is visible on the periphery of the view. Views of the site are unobstructed from this location.

Vol 16 Plate 11.4.33 Viewpoint 2.8: summer view

Date taken: 2 August 2011. 18mm lens.

11.4.121 In summer, the view towards the site (illustrated in Vol 16 Plate 11.4.33) is largely unchanged.

11.4.122 At night, the view is characterised by light spill from buildings, in addition to street lighting along the Thames Path, on the south bank of the river. However, the unlit expanse of river forms the key component of the foreground view at night.

Viewpoint 2.9: View southeast from the north end of Atterbury Street

11.4.123 This viewpoint is recorded as a local view by the Westminster City Council. This viewpoint is representative of the typical view for pedestrians walking down Atterbury Street towards the river.

Vol 16 Plate 11.4.34 Viewpoint 2.9: winter view

Date taken: 21 November 2011. 18mm lens.

11.4.124 The linear view (illustrated in Vol 16 Plate 11.4.34) focused along Atterbury Street is framed by Tate Britain art gallery to the north (left) and Chelsea College to the south (right). Views towards the river are partially obscured by mature tree planting along Atterbury Street. Views towards the site are largely obscured by buildings along Atterbury Street, in addition to the mature trees.

Viewpoint 2.10: View southeast from the entrance to Tate Britain

11.4.125 This viewpoint is representative of the typical view for recreational users of Tate Britain, located at the entrance to the art gallery. The view is recorded as a local view by the Westminster City Council.

Vol 16 Plate 11.4.35 Viewpoint 2.10: winter view

Date taken: 21 November 2011. 18mm lens.

11.4.126 The view (illustrated in Vol 16 Plate 11.4.35) is a panorama over the river, heavily characterised by the foreground presence of heavy traffic and the avenue of mature London plane trees along the north bank. Views to the river and opposite bank are filtered by mature trees, which limit views towards the site.

Viewpoint 2.11: View south from the Thames Path opposite Thames House

11.4.127 This viewpoint is representative of the typical view pedestrians experience while walking south along the Thames Path, from outside Thames House close to Lambeth Bridge.

Vol 16 Plate 11.4.36 Viewpoint 2.11: winter view

Date taken: 21 November 2011. 18mm lens.

11.4.128 The linear view (illustrated in Vol 16 Plate 11.4.36) up the river is focused on commercial buildings along the river frontage of the south bank, including Camelford House and the Vauxhall Cross building close to the site. Views of the site are largely unobstructed from this location, apart from some obstruction by Millbank Millennium Pier in the middle ground of the view.

Construction base case

11.4.129 The base case in Site Year 2 of construction taking into account the schemes described in para. 11.3.14 would change the following character areas:

a. River Thames – Nine Elms Reach TCA - By Site Year 2 of construction, the conversion of a number of industrial units and disused plots of land into new residential and mixed use developments (Riverlight, Battersea Power Station, New Covent Garden, St Georges Wharf, the US Embassy, Embassy Gardens and Vauxhall Sky Tower) would alter the setting of this stretch of the river. However, as there would be no changes to character within the area, the sensitivity would remain medium as described in para. 11.4.33.

b. Albert Embankment Commercial TCA – By Site Year 2 of construction, the assumed completion of the Hampton House, 10 Albert Embankment and Parliament House developments would alter the character of part of this area. The developments would replace existing components in poor states of repair, raising the overall condition of the area to good. Despite the low levels of tranquillity, which would remain unchanged, the sensitivity of this area would change from medium to high.

c. St George's Wharf Residential TCA – By Site Year 2 of construction, the assumed completion of the Vauxhall Tower and Market Towers developments would further extend the character of the core part of this area, centred on the existing St George's Wharf development. However, the overall character of the area would remain largely unchanged and sensitivity would remain high as described in para. 11.5.30.

d. Residential Waterfront – West TCA – By Site Year 2 of construction, the assumed completion of the Riverwalk House development would further improve the condition of the river frontage of this area. However, the overall character of the area would remain largely unchanged and sensitivity would remain high as described in para. 11.4.59.

11.4.130 All other receptors would remain as described in the baseline.

Operational base case

11.4.131 The base case in Year 1 of operation taking into account the schemes described in para. 11.3.22 would further alter the setting of River Thames – Nine Elms Reach TCA through further regeneration of industrial and commercial plots into new mixed use developments. However, it is considered that the sensitivity of the area would remain medium, as described in para. 11.4.33.

11.4.132 All other receptors would remain as described in the baseline.

11.5 Construction effects assessment

11.5.1 The following section describes the likely significant effects arising from construction at Albert Embankment Foreshore taking account of Heathwall Pumping Station, Kirtling Street and Chelsea Embankment Foreshore (as detailed in Section 11.3).

11.5.2 Construction effects on the site, surrounding townscape character areas and visual assessment viewpoints would not be altered by the alternative construction access between Camelford House and Tintagel House (as opposed to via Lack's Dock and Albert Embankment). Therefore, this is not repeated for each receptor described below.

11.5.3 Due to the scale of the construction activities proposed across what are, in many cases, prominent locations in London, construction works would be highly visible. In policy terms, the NPS for Waste Water[7] recognises that nationally significant infrastructure projects are likely to take place in mature urban environments, with adverse construction effects on townscape and visual receptors likely to arise. In addition, construction works are a commonplace feature across London, and therefore the following assessment should be viewed in this context. It should also be noted that construction effects are temporary in nature and relate to the peak construction year defined in Section 11.3. Effects during other phases of works are likely to be less due to fewer construction plan being required at the time and a reduced intensity of construction activity.

11.5.4 Illustrative plans of the possible layout of the site during construction are contained in a separate volume (Construction phase plans, see separate volume of figures – Section 1).

Site character assessment

11.5.5 Temporary effects on the character of the site would arise from partial removal of the river wall, removal of lamp standards, installation of site hoardings and welfare facilities, and construction activity associated with the construction of the cofferdam, shaft and ventilation equipment, interception works at Vauxhall Bridge and secondary lining of the tunnel. The impacts on specific components of the site are described in Vol 16 Table 11.5.1 below. The two construction access options (Option A – Lack's dock and Option B – temporary road access between Camelford House and Tintagel House) would have different impacts on the existing site components, and therefore these differences are presented in Vol 16 Table 11.5.1 below.

Vol 16 Table 11.5.1 Townscape – impacts on existing site components during construction

ID	Component	Impacts
01	Downstream river wall	Parts of the river wall would require removal to facilitate the new construction site projecting into the river in both access options.
02	Thames Path	The Thames Path surface would be removed as part of construction. The route of the Thames Path would be diverted onto Albert Embankment road in both access options.
03	Handrailing	Handrailing removed during construction in both access options.
04	Trees and shrubs	Option A: Three trees and some low level shrubs would be pruned but retained during construction. Some shrubs along Lack's Dock would be removed.
		Option B: Two trees and some low level shrubs along the ramp of the basement car park would be removed.
05	Raised planters	Raised planters would be removed in both access options.
06	Concrete wall	Option A: The concrete wall would be removed.
		Option B: No construction impacts.
07	Lack's Dock boundary wall	Option A: The boundary wall would be removed.
		Option B: No construction impacts.

ID	Component	Impacts
08	Thames Path boundary wall	Option A: No construction impacts.
		Option B: The boundary wall would be removed.
09	Ramp	Option A: No construction impacts.
		Option B: Part of the ramp would be removed.
10	Security kiosk	Option A: The security kiosk would be removed.
		Option B: No construction impacts.

11.5.6 The existing site has a low level of tranquillity, which be affected to a limited extent by the introduction of construction vehicles, plant equipment and high levels of activity in a part of the river and Thames Path not currently intensively used.

11.5.7 Due to the substantial changes in character and changes to tranquillity arising from the construction activity, the magnitude of change is considered to be high.

11.5.8 The high magnitude of change, assessed alongside the medium sensitivity of the site, would result in **major adverse** effects. This assessment on the character of the site has considered both access Options A and B and given that the differences described in Vol 16 Table 11.5.1 above are not substantial, the assessment reflects both options.

11.5.9 The assessment of specific effects on the setting of Albert Embankment Conservation Area as a heritage asset is set out in Section 7 of this volume. The historic environment assessment identifies a moderate adverse on the setting of this asset as the conservation area is larger than the area defined as the site. Therefore, the changes within the site affect only a proportion of the conservation area, with part of the setting unaffected.

Townscape character areas assessment

River Thames – Nine Elms Reach TCA

11.5.10 The proposed site is immediately adjacent to this reach of the river, with the majority of the site (apart from the CSO interception works) separated by Vauxhall Bridge. Construction activity would be set within the immediate setting of this character area, partially screened by the presence of Vauxhall Bridge.

11.5.11 The proposed Heathwall Pumping Station and Kirtling Street sites are also within this reach of the river, introducing high levels of construction activity within the river corridor, including an industrial jetty and intense construction activity. However, the construction activity at both these sites would be typical of other operations in the area such as the waste transfer station adjacent to the Kirtling Street site.

11.5.12 The wider setting would also be affected to a limited extent by construction activity at the Chelsea Embankment Foreshore site.

11.5.13 Due to construction activity at all three sites set against an existing presence of industrial activities, the magnitude of change is considered to be medium.

11.5.14 The area has a moderate level of tranquillity at present, which would be affected through the introduction of construction activity at these sites, including piling, demolition and river and road based traffic.

11.5.15 Due to construction activity at all four sites, set against an existing presence of industrial activities, the magnitude of change is considered to be medium.

11.5.16 The medium magnitude of change, assessed alongside the medium sensitivity of this character area, would result in **moderate adverse** effects.

River Thames – Vauxhall and Pimlico Reach TCA

11.5.17 The proposed site is adjacent to this reach of the river, introducing high levels of construction activity within the river corridor. Between Vauxhall Bridge and Lambeth Bridge, the reach would become heavily characterised by construction activity associated with the site.

11.5.18 The moderate levels of tranquillity in the area would be affected by the introduction of construction activity, including piling.

11.5.19 Due to the intense levels of construction activity within the river corridor, affecting both the character and tranquillity of the area, the magnitude of change is considered to be high.

11.5.20 The high magnitude of change, assessed alongside the high sensitivity of this character area, would result in **major adverse** effects.

Albert Embankment Commercial TCA

11.5.21 The proposed site is set directly west of this character area, separating the local area from the river. The setting of buildings fronting the river (including Vauxhall Cross and Camelford House) would be affected by the presence of the site cofferdam, construction activity, construction plant and traffic, particularly in the vicinity of the shaft location. The setting of the character area would be affected by the presence of site hoardings and welfare facilities, altering the current open aspect over the river. However, the majority of the area's riverside setting would be largely unaffected.

11.5.22 The area has a low level of tranquillity at present, which would be altered to a limited extent by construction activity at the site, including piling.

11.5.23 Due to the changes in the immediate riverside setting of part o the area, the magnitude of change is considered to be medium.

11.5.24 The medium magnitude of change, assessed alongside the high sensitivity of this character area, would result in **moderate adverse** effects.

11.5.25 The assessment of specific effects on the setting of Albert Embankment Conservation Area and Vauxhall Cross as heritage assets is set out in Section 7 of this volume. The historic environment assessment identifies a minor adverse effect on the setting of Vauxhall Cross due to differences between the townscape and visual and historic environment methodologies.

St George's Wharf Residential TCA

11.5.26 The proposed site forms part of the immediate setting of this character area, set just beyond Vauxhall Bridge. The presence of the temporary cofferdam, construction activity and construction plant at this site would affect the riverside setting of the character area, forming a key component of the setting for the duration of construction.

11.5.27 This character area is also located within the assessment areas for the Kirtling Street and Heathwall Pumping Station sites. These sites would partially affect the wider setting of this area by the presence of construction activity, cranes, the temporary cofferdam at Heathwall Pumping Station and the river jetty at Kirtling Street.

11.5.28 The area has a moderate level of tranquillity at present, which would be affected through the introduction of construction activity, including piling, demolition and river and road based traffic in the wider area.

11.5.29 Due to the immediate change in setting arising from construction activity at Albert Embankment Foreshore, and the wider changes in setting arising from activities at Kirtling Street and Heathwall Pumping Station, the magnitude of change is considered to be high.

11.5.30 The high magnitude of change, assessed alongside the medium sensitivity of this character area, would result in **moderate adverse** effects.

Nine Elms Lane Residential TCA

11.5.31 The proposed site forms part of the wider riverside setting of this character area, albeit separated by Vauxhall Bridge. The presence of the cofferdam and construction activity, particularly at the CSO interception works at Vauxhall Bridge would affect the wider setting this area.

11.5.32 This character area is also located within the assessment areas for the Kirtling Street and Heathwall Pumping Station sites. These sites would partially affect the wider setting of this area by the presence of construction activity, construction plant, the temporary cofferdam at Heathwall Pumping Station and the river jetty at Kirtling Street. However, the majority of the areas riverside setting would be largely unaffected.

11.5.33 The area has a moderate level of tranquillity at present, which would be affected through the introduction of construction activity, including piling, demolition and river and road based traffic in the wider area.

11.5.34 Therefore, the magnitude of change arising from the presence of construction activity at all three sites is considered to be medium.

11.5.35 The medium magnitude of change, assessed alongside the medium sensitivity of this character area, would result in **moderate adverse** effects.

Residential Waterfront – West TCA; and Millbank Conservation Area – Institutional TCA

11.5.36 The proposed site forms a direct part of the riverside setting of these character areas. The presence of the site cofferdam, construction activity, construction plant, welfare facilities and the CSO interception works under Vauxhall Bridge would affect the riverside setting of this character area.

11.5.37 The moderate levels of tranquillity in the areas would be affected to a limited extent by construction activities at the site, including piling.

11.5.38 Due to the substantial changes to the immediate riverside setting of these areas, the magnitude of change is considered to be high.

11.5.39 The high magnitude of change, assessed alongside the high sensitivity of these character areas, would result in **major adverse** effects.

11.5.40 The assessment of specific effects on the setting of Millbank Conservation Area as a heritage asset is set out in Section 7 of this volume. The historic environment assessment identifies a minor adverse on the setting of this asset as the setting of a number of notable listed buildings within the conservation area would be largely unaffected. Therefore, the changes to the heritage assets would be less substantial than the changes to the overall townscape character of this area, which is highly focused on the river.

Westminster Residential TCA

11.5.41 The proposed site forms part of the wider riverside setting of this character area, although it is largely inward looking in character. The presence of the site cofferdam, construction activity, construction plant and the CSO interception works under Vauxhall Bridge would affect the riverside setting of this character area. However, the setting of the majority of the area would be unaffected.

11.5.42 The moderate levels of tranquillity in the areas would be affected to a limited extent by construction activities at the site, including piling.

11.5.43 Due to changes in part of the areas wider riverside setting and the limited changes to tranquillity, the magnitude of change is considered to be low.

11.5.44 The low magnitude of change, assessed alongside the high sensitivity of this character area, would result in **minor adverse** effects.

Townscape – sensitivity test for programme delay

11.5.45 For the assessment of townscape effects during construction, a delay to the Thames Tideway Tunnel project of approximately one year would not be likely materially to change the assessment findings reported above (paras. 11.5.5 to 11.5.44). The Nine Elms Regeneration area (to the west of the proposed development) is subject to ongoing and long term change, and a delay to the Thames Tideway Tunnel project is not likely to change the sensitivity to change of the townscape character areas already presented (paras. 11.4.2 to 11.4.71).

Visual assessment

11.5.46 The visual assessment for the construction phase has been undertaken during winter, in line with best practice guidance, to ensure a robust assessment. However, in some cases, visibility of construction activities may be reduced during summer when vegetation, if present in a view, would be in leaf.

Residential

Viewpoint 1.1: View northeast and southwest from residences on Nine Elms Lane

11.5.47 Wider panoramic views of the river would be affected by the presence of construction activity and construction plant at the Albert Embankment Foreshore site, although they would be partially obscured by Vauxhall Bridge. CSO interception works would be highly visible set in front of Vauxhall Bridge.

11.5.48 The view towards the Kirtling Street and Heathwall Pumping Station sites would be affected by the presence of construction activity, construction plant, the river jetty and 24 hour loading of barges at Kirtling Street and the site cofferdam at Heathwall Pumping Station, in the background of the view. The majority of the wider panoramic view across the river would be largely unaffected.

11.5.49 Due to the wider visibility of construction activity at all three sites and the visibility of the interception works at Albert Embankment Foreshore in front of Vauxhall Bridge, the magnitude of change is considered to be medium.

11.5.50 The medium magnitude of change, assessed alongside the high sensitivity of the receptor, would result in **moderate adverse** effects.

Viewpoint 1.2: View northeast and southwest from residences on Grosvenor Road opposite St George's Square; and Viewpoint 1.3: View northeast and southwest from residences on Grosvenor Road near Balvaird Place

11.5.51 Views from these locations towards the Albert Embankment Foreshore site would be affected by the background visibility of the site cofferdam, construction activity, tall construction plant and welfare facilities, partially obscured by Vauxhall Bridge. The CSO interception works upstream of the bridge would be directly visible in the middle ground of the views.

11.5.52 Views towards the Kirtling Street and Heathwall Pumping Station sites would be affected by the presence of construction activity, construction plant, welfare facilities, the river jetty at Kirtling Street and the site cofferdam at Heathwall Pumping Station. The majority of the immediate views across the river would remain unaffected, and the construction would appear alongside other existing industrial uses.

11.5.53 Due to the wider visibility of construction activity at all three sites and the direct visibility of the CSO interception works at Albert Embankment Foreshore, the magnitude of change is considered to be medium.

11.5.54 The medium magnitude of change, assessed alongside the high sensitivity of these receptors, would result in **moderate adverse** effects.

Viewpoint 1.4: View southeast from residences at the junction of Ponsonby Place and Causton Street

11.5.55 The background of the view from residences towards the site, currently dominated by Camelford House, would be characterised by construction activity around the shaft, including tall construction plant and cranes. This construction activity would partially obscure views of Camelford House. However, due to the distance between the viewpoint and the site, and the unchanged foreground of the view, the magnitude of change is considered to be low.

11.5.56 The low magnitude of change, assessed alongside the high sensitivity of the receptor, would result in **minor adverse** effects.

Recreational

Viewpoint 2.1: View south from Lambeth Bridge; and Viewpoint 2.11: View south from the Thames Path opposite Thames House

11.5.57 Views from these locations would be affected during construction, due to the presence of the site cofferdam, construction activity, construction plant and welfare facilities in the background of the views. Views of construction activity would be unobstructed from these locations. However, the foreground of the views would be unaltered and the majority of the wider panorama over the river would be largely unaffected. Therefore, the magnitude of change is considered to be low.

11.5.58 The low magnitude of change, assessed alongside the high sensitivity of these receptors, would result in **minor adverse** effects.

Viewpoint 2.2: View south from the Thames Path at the southern end of Lambeth Bridge

11.5.59 Views from this location would be affected during construction, due to the presence of the site cofferdam, construction activity, construction plant and welfare facilities in the background of the view. Views of construction activity would be partially obstructed from this location by an intervening river pier. The foreground of the view would be unaltered. Therefore, the magnitude of change is considered to be low.

11.5.60 The low magnitude of change, assessed alongside the high sensitivity of the receptor, would result in **minor adverse** effects.

Viewpoint 2.3: View southwest from the Thames Path opposite Park Plaza

11.5.61 Views from this location would be affected during construction, due to the presence of the site cofferdam, construction activity, construction plant and welfare facilities in the background of the view, set in front of Vauxhall Bridge. Views of construction activity would be unobstructed from this location. However, the wider panorama over the river would be largely unaltered. Therefore, the magnitude of change is considered to be medium.

11.5.62 The medium magnitude of change, assessed alongside the high sensitivity of the receptor, would result in **moderate adverse** effects.

Viewpoint 2.4: View southwest from the Thames Path outside Peninsula Heights; and Viewpoint 2.5: View northeast from the southern end of Vauxhall Bridge

11.5.63 Views from these locations would be affected during construction, due to the presence of the site cofferdam, construction activity, construction plant, welfare facilities and site hoardings in the foreground of the views. Views of construction activity would be unobstructed from this location, beyond the line of site hoardings. Therefore, the magnitude of change is considered to be high.

11.5.64 The high magnitude of change, assessed alongside the high sensitivity of these receptors, would result in **major adverse** effects.

11.5.65 The assessment of specific effects on the setting of the Grade II* listed Vauxhall Bridge as a heritage asset is set out in Section 7 of this volume. The historic environment assessment identifies a moderate adverse on the setting of this asset as the setting is wider than the field of view experienced by a pedestrian crossing the bridge in this location. Therefore, much of the setting of the bridge would be largely unchanged, as opposed to the substantial change visible from this specific viewpoint.

Viewpoint 2.6: View northeast and southwest from the Thames Path south of St George's Wharf

11.5.66 Views from this location would be affected during construction. Wider panoramic views of the river would be affected by the presence of construction activity and construction plant at the Albert Embankment Foreshore site, partially obscured by Vauxhall Bridge. CSO interception works would be highly visible set in front of Vauxhall Bridge in the middle ground of the view.

11.5.67 Views towards the Kirtling Street and Heathwall Pumping Station sites would be affected by the presence of construction activity, construction plant, the river jetty at Kirtling Street and the site cofferdam at Heathwall Pumping Station. The construction activities would be set against other industrial uses, including the waste transfer station and Cemex concrete batching plant adjacent to the Kirtling Street site. The remainder of the panoramic view across the river would remain unaffected.

11.5.68 Due to the wider visibility of construction activity at all three sites and the direct visibility of the CSO interception works at Albert Embankment Foreshore, the magnitude of change is considered to be medium.

11.5.69 The medium magnitude of change, assessed alongside the high sensitivity of the receptor, would result in **moderate adverse** effects.

Viewpoint 2.7: View east from the northern end of Vauxhall Bridge; and Viewpoint 2.8: View east from the Thames Path at an open space along Millbank

11.5.70 Views from these locations would be affected during construction, due to the presence of the site cofferdam, construction activity, construction plant and welfare facilities in the direct cross-river view. Views of construction activity would be unobstructed from these locations, beyond the line of site hoardings. Although wider views of the river would be largely unaffected, the scale of the construction activities in the immediate views means the magnitude of change is considered to be high.

11.5.71 The high magnitude of change, assessed alongside the high sensitivity of these receptors, would result in **major adverse** effects.

Viewpoint 2.9: View southeast from the north end of Atterbury Street

11.5.72 Construction activity at the site would be barely perceptible from this location, due to foreground buildings and mature trees obscuring the view towards the site and the river. Therefore, the magnitude of change on this view would be negligible.

11.5.73 The negligible magnitude of change, assessed alongside the high sensitivity of the receptor, would result in a **negligible** effect.

Viewpoint 2.10: View southeast from the entrance to Tate Britain

11.5.74 Views from this location would be affected to a limited extent during construction, due to the presence of the site cofferdam, construction activity, construction plant and welfare facilities in the view across the river, heavily screened by foreground vegetation. The foreground of the view, characterised by the Embankment, would remain unaffected. Therefore, the magnitude of change is considered to be low.

11.5.75 The low magnitude of change, assessed alongside the high sensitivity of the receptor, would result in **minor adverse** effects.

Visual effects – sensitivity test for programme delay

11.5.76 For the assessment of visual effects during construction, a delay to the Thames Tideway Tunnel project of approximately one year would not be likely materially to change the assessment findings reported above (paras. 11.5.47 to 11.5.75). This is on the basis that there are no known schemes within the assessment area that would introduce new visual receptors, or alter visibility of the proposed development from the viewpoints described in paras. 11.4.73 to 11.4.128.

11.6 Operational effects assessment

11.6.1 The following section describes the likely significant effects arising during the operational phase at Albert Embankment Foreshore taking account of the Heathwall Pumping Station and Kirtling Street sites (as detailed in Section 11.3).

11.6.2 Effect on tranquillity is one factor which informs the overall assessment of effects on townscape character. Since the operation of the proposed development would have little above-ground activity associated with it, apart from infrequent maintenance visits, it is considered that the proposed development would have a negligible effect on tranquillity for all townscape character areas. This conclusion is not repeated for each character area discussed below.

11.6.3 For the site, all surrounding townscape character areas and all viewpoints, adverse effects would be minimised by the commitment to a high quality design as detailed in the *Design Principles* report and proposed landscape plan (see separate volume of figures – Section 1), summarised in para. 11.2.6. Where specific measures are of particular relevance with the effect on a receptor, these are described under each townscape character area and viewpoint.

11.6.4 Illustrative plans of the proposed development during operation are contained in a separate volume (Volume 16 Albert Embankment Foreshore Figures) and design principles describing environmental design measures are set out in Vol 1 Appendix B. Where photomontages have been prepared to assist the assessment of effects, these are referenced in the appropriate viewpoint below.

Operational effects Year 1

Site character assessment

11.6.5 The proposed development would have a permanent effect on the character of the site. The permanent layout would result in a new area of public realm along Albert Embankment that would project into the river by approximately 26m. This projection would introduce a new structure into the river beyond the line of the river wall in a stretch of river characterised by numerous incursions and insets, including jetty structures and Lack's dock (immediately adjacent to the site). The river wall surrounding the foreshore structure would have a high quality concrete finish in keeping with the character of surrounding river walls. The wall would incorporate horizontal bands to mark river levels and vertical timber fenders. The design intent for the river wall is illustrated on the Typical river wall design intent figure (see separate volume of figures – Section 1).

11.6.6 A 4-8m high, well designed ventilation column would be located in the western section of the new foreshore structure, and a 1.5m-2.5m high electrical and control kiosk would be located along the landward edge of the new structure. The design intent for the ventilation column (which would be the project signature design) is illustrated on the Ventilation columns design intent figure – type B (see separate volume of figures – Section 1). An indicative drawing of the design intent for the electrical and control kiosk, which would incorporate stainless steel cladding, is shown on the Kiosk design intent figure (see separate volume of figures – Section 1).

11.6.7 The CSO interception works would result in a permanent projection around the base of Vauxhall Bridge, adversely affecting the setting of the bridge by partially obscuring the existing bridge geometry. The river wall for the interception chamber would be formed from a series of high quality concrete terraces, incorporating aquatic planting. The structure would be set below the springing point of the bridge. A narrow 6m high ventilation column and 1.2m high local control pillar would be located on the interception chamber structure downstream of Vauxhall Bridge. The electrical and control kiosk for the interception chamber would be located within an existing void underneath Vauxhall Bridge.

11.6.8 The land based area of the construction site would be returned to its original or an improved condition at completion. The works would result in an improvement to the public realm outside Camelford House, widening the Thames Path. The impacts on specific components of the site are described in Vol 16 Table 11.6.1 below.

Vol 16 Table 11.6.1 Townscape – impacts on baseline components in Year 1 of operation

ID	Component	Impacts
01	Downstream river wall	In the site working area, the existing river wall would be obscured behind the new projection into the river, with a new river wall constructed, using materials in character with the surrounding stretches of river wall.
02	Thames Path	The Thames Path would be reinstated to the riverside location and resurfaced following the main works.
03	Handrailing	Where required, handrailings would be replaced with new ones in keeping with the design of the public realm.
04	Trees and shrubs	Option A:Three silver birch trees and some shrubs would be retained. Shrubs removed along Lack's Dock would be replaced, and new trees proposed as part of the landscape design proposals.
		Option B: New trees and shrubs would be planted to compensate for the loss of the existing vegetation.
05	Raised planters	Raised planters would be removed with the new landscape proposals.
06	Concrete wall	Option A: The concrete wall would be reinstated.
		Option B: No operational impacts.
07	Lack's Dock boundary wall	Option A: The boundary wall would be reinstated.
		Option B: No operational impacts.
08	Thames Path boundary wall	Option A: No operational impacts.
		Option B: The boundary wall would be reinstated.
09	Ramp	Option A: No operational impacts
		Option B: The boundary wall would be reinstated.
10	Security kiosk	Option A: The security kiosk and barrier would be replaced.
		Option B: No operational impacts.

11.6.9 Due to the creation of a new area of high quality public realm, replacing components in a poor existing state of repair, the magnitude of change is considered to be medium.

11.6.10 The medium magnitude of change, assessed alongside the medium sensitivity of the site, would result in **moderate beneficial** effects. This assessment on the character of the site has considered both access Options A and B and given that the differences described in Vol 16 Table 11.6.1 above are not substantial, the assessment reflects both options.

11.6.11 The assessment of specific effects on the setting of Albert Embankment Conservation Area as a heritage asset is set out in Section 7 of this volume. The historic environment assessment identifies a minor adverse on the setting of this asset due to some alterations to the historic character.

Townscape character areas assessment

11.6.12 This section describes effects arising from the proposed development in operation on townscape character areas surrounding the site. No assessment of townscape effects has been made for the following character areas, as the components of the operational scheme would not alter their setting:

a. Nine Elms Lane Residential

b. Westminster Residential.

River Thames – Nine Elms Reach TCA

11.6.13 The proposed development at Albert Embankment Foreshore would not substantially alter the setting of this character area. However, the CSO interception chamber on either side of Vauxhall Bridge would affect the setting of the reach to a limited extent by slightly altering the appearance of Vauxhall Bridge, an important part of this area’s character. The change would be minimised through terracing to blend the interception chamber on the west side of the bridge into the surrounding foreshore, representing an improvement to the existing CSO outfalls which are highly visible adjacent to the bridge.

11.6.14 The Heathwall Pumping Station site would locally improve the setting of this character area by creating a public pedestrian frontage along the river and by partially screening the existing pumping station through new planting and well designed structures. The Kirtling Street site would also locally improve the setting of this character area through the demolition of existing dilapidated buildings and structures. However, the majority of the areas setting would be largely unaffected.

11.6.15 Due to the improvements in setting introduced by components of the proposed development at all three sites, the magnitude of change is considered to be low.

11.6.16 The low magnitude of change, assessed alongside the medium sensitivity of this character area, would result in **minor beneficial** effects.

River Thames – Vauxhall and Pimlico Reach TCA; Residential Waterfront – West TCA; and Millbank Conservation Area – Institutional TCA

11.6.17 The proposed development would result in the permanent loss of an area of foreshore, due to the foreshore structure projecting into the river by approximately. The projection would result in a slight degradation of the link between the river and Albert Embankment. However, this is partially minimised by the site's location in an indentation along the river, characterised by a different type of river wall to the listed stretch further downstream. The CSO interception chamber on either side of Vauxhall Bridge would affect the setting of these areas to a limited extent by altering the appearance of Vauxhall Bridge, an important component of the areas character. The change would be partially minimised through terracing to blend the interception chamber on the east side of the bridge into the surrounding foreshore. The above ground structures, including the ventilation columns and control kiosks, would introduce new built elements into the area, but their design, facade materials and locations would be in keeping with the surrounding character.

11.6.18 Due to the changes in a relatively small part of the riverside setting of these areas, the magnitude of change is considered to be low.

11.6.19 The low magnitude of change, assessed alongside the high sensitivity of the character areas, would result in **minor adverse** effects.

11.6.20 The assessment of specific effects on the setting of Millbank Conservation Area as a heritage asset is set out in Section 7 of this volume.

Albert Embankment Commercial TCA

11.6.21 The proposed development would result in this character area being locally extended into the river by virtue of the permanent projection resulting from the shaft construction and interception works. This would particularly affect the setting of Camelford House and Vauxhall Cross. The public realm along the riverfront would be locally widened and improved as a result of the works.

11.6.22 Due to the improvement in a part of the areas riverside setting, the magnitude of change is considered to be low.

11.6.23 The low magnitude of change, assessed alongside the high sensitivity of the area, would result in **minor beneficial** effects.

11.6.24 The assessment of specific effects on the setting of Albert Embankment Conservation Area and Vauxhall Cross as heritage assets is set out in Section 7 of this volume. The historic environment assessment identifies a minor adverse on the setting of these assets due to some alterations to the historic character.

St George's Wharf Residential TCA

11.6.25 The proposed main site would not substantially alter the setting of this character area. However, the CSO interception structure on either side of Vauxhall Bridge would marginally affect the setting of the reach by altering the appearance of Vauxhall Bridge, an important component in the immediate setting of this character area. The change would be partially minimised through terracing to blend the interception chamber into the surrounding foreshore. Therefore, the magnitude of change is considered to be negligible.

11.6.26 The negligible magnitude of change, assessed alongside the medium sensitivity of this character area, would result in a **negligible** effect.

Townscape – sensitivity test for programme delay

11.6.27 For the assessment of townscape effects during operation, a delay to the Thames Tideway Tunnel project of approximately one year would not be likely materially to change the assessment findings reported above (paras. 11.6.5 to 11.6.26). This is on the basis that there are no known schemes that would change the sensitivity to change of the townscape character areas already presented (paras. 11.4.2 to 11.4.71).

Visual assessment

11.6.28 For each viewpoint, an assessment of the visual effects during Year 1 of operation has been made. In each instance, the first part of the assessment relates to visual effects during winter, the second part relates to visual effects during summer and the final part relates to visual effects at night time arising from operational lighting.

11.6.29 No assessment of visual effects has been made for the following viewpoints, as the components of the operational scheme would not be visible or would be barely perceptible in the background of the view:

a. Viewpoint 1.1: View northeast and southwest from residences on Nine Elms Lane

b. Viewpoint 1.2: View northeast and southwest from residences on Grosvenor Road opposite St George's Square

c. Viewpoint 1.3: View northeast and southwest from residences on Grosvenor Road near Balvaird Place

d. Viewpoint 1.4: View southeast from residences at the junction of Ponsonby Place and Causton Street

e. Viewpoint 2.2: View south from the Thames Path at the southern end of Lambeth Bridge

f. Viewpoint 2.9: View southeast from the north end of Atterbury Street

g. Viewpoint 2.10: View southeast from the entrance to Tate Britain

h. Viewpoint 2.11: View south from the Thames Path opposite Thames House.

Recreational

Viewpoint 2.1: View south from Lambeth Bridge

11.6.30 The proposed development would be visible in the background of this view. The components of the site, including the river wall and ventilation columns would be barely perceptible and would not represent skyline features. Therefore, the magnitude of change is considered to be negligible.

11.6.31 The negligible magnitude of change, assessed alongside the high sensitivity of the receptor, would result in a **negligible** effect.

11.6.32 There would be no change to the assessment during summer.

11.6.33 At night, lighting at the site (including public realm lighting and illumination of the ventilation columns), would be barely perceptible in the background of the view. Therefore, the magnitude of change is considered to be negligible.

11.6.34 The negligible magnitude of change, assessed alongside the high sensitivity of the receptor would give rise to a **negligible** effect at night.

Viewpoint 2.3: View southwest from the Thames Path opposite Park Plaza

11.6.35 Views from this location would be affected by the design of the new river wall, above ground structures and, to a limited extent, the CSO interception works. The new structures would form a component of the background of the view, set in front of Camelford House, Vauxhall Cross and Vauxhall Bridge. The proposed works in front of the existing river wall and alongside Vauxhall Bridge, and the introduction of built elements in the currently undeveloped river channel would be give rise to adverse effects on this viewpoint. The view of the proposed development from this viewpoint is illustrated in Vol 16 Plate 11.6.1 below. A larger scale print of the photomontage, including the wider context and annotations, is provided in Vol 16 Figure 11.6.1 (see separate volume of figures). The layout of the proposed development illustrated in this photomontage may change within the zones shown on the Site works parameter plan (see separate volume of figures – Section 1), however the assessment of effects would be no worse than that described here.

Vol 16 Plate 11.6.1 Viewpoint 2.3 – illustrative operational phase photomontage

Date taken: 17 March 2011. 50mm lens.

11.6.36 Due to the noticeable changes in the view, although broadly in keeping with the existing townscape character, the magnitude of change is considered to be low.

11.6.37 The low magnitude of change, assessed alongside the high sensitivity of the receptor, would result in **minor adverse** effects.

11.6.38 In summer, the components of the proposed development would be largely screened by foreground trees along the river frontage. Therefore, the magnitude of change is considered to be negligible, resulting in a **negligible** effect during summer.

11.6.39 At night, lighting at the site (including public realm lighting and illumination of the ventilation columns), would be barely perceptible in the background of the view. Therefore, the magnitude of change is considered to be negligible.

11.6.40 The negligible magnitude of change, assessed alongside the high sensitivity of the receptor would give rise to a **negligible** effect at night.

Viewpoint 2.4: View southwest from the Thames Path outside Peninsula Heights; and Viewpoint 2.5: View northeast from the southern end of Vauxhall Bridge

11.6.41 Views from these locations would be affected by the design of the new river wall, above ground structures, public realm and, to a limited extent, the CSO interception structure. The new structures would form a new component of the foreground of the views, set in front of Camelford House, Vauxhall Cross and Vauxhall Bridge. The works would be considered an improvement to the character of the existing public realm, improving the view from these receptors. The view of the proposed development from this viewpoint is illustrated in Vol 16 Plate 11.6.2 below. A larger scale print of the photomontage, including the wider context and annotations, is provided in Vol 16 Figure 11.6.2 (see separate volume of figures). The layout of the proposed development illustrated in this photomontage may change within the zones shown on the Site works parameter plan (see separate volume of figures – Section 1), however the assessment of effects would be no worse than that described here.

Vol 16 Plate 11.6.2 Viewpoint 2.5 – illustrative operational phase photomontage

Date taken: 17 March 2011. 50mm lens.

11.6.42 Due to the foreground change in the character of the views, resulting from the improvements to the public realm and river wall and high quality design of the above ground structures, the magnitude of change is considered to be medium.

11.6.43 The medium magnitude of change, assessed alongside the high sensitivity of these receptors, would result in **moderate beneficial** effects.

11.6.44 There would be no change to the assessment during summer.

11.6.45 At night, lighting at the site (including public realm lighting and illumination of the ventilation columns) would be visible in the foreground of the views, although they would be capped and directional units in line with the generic lighting design standards. The lighting would be viewed against a fairly brightly lit context of light spill from buildings along the river frontage. The view at night from viewpoint 2.5 is reflected in the photomontage shown in Vol 16 Plate 11.6.3. The layout of the proposed development illustrated in this photomontage may change within the zones shown on the Site works parameter plan (see separate volume of figures – Section 1), however the assessment of effects would be no worse than that described here.

Vol 16 Plate 11.6.3 Viewpoint 2.5 – illustrative night time operational phase photomontage

Date taken: 16 August 2012. 50mm lens.

11.6.46 Therefore, the magnitude of change is considered to be negligible.

11.6.47 The negligible magnitude of change, assessed alongside the high sensitivity of the receptor would give rise to a **negligible** effect at night.

11.6.48 The assessment of specific effects on the setting of the Grade II* listed Vauxhall Bridge as a heritage asset is set out in Section 7 of this volume. The historic environment assessment identifies a minor adverse on the setting of this asset due to some alteration of the historic character within the setting of the bridge.

Viewpoint 2.6: View northeast and southwest from the Thames Path south of St George's Wharf

11.6.49 Views from this location towards the Albert Embankment Foreshore site would be largely obscured by the arches of Vauxhall Bridge, although the river wall around the new foreshore structure and the above ground structures would be intermittently visible. The interception chambers on either side of Vauxhall Bridge would be visible. The magnitude of change would be minimised through surrounding the interception works with terraces to blend them into the surrounding foreshore, particularly on the west side of the bridge in the direct frame of view.

11.6.50 The proposed developments at Heathwall Pumping Station and Kirtling Street would be barely perceptible in the background of the view.

11.6.51 Due to the visibility of the interception works at Albert Embankment Foreshore, disguised through use of terraces, the magnitude of change is considered to be negligible.

11.6.52 The negligible magnitude of change, assessed alongside the high sensitivity of the receptor, would result in a **negligible** effect.

11.6.53 There would be no change to the assessment during summer.

11.6.54 At night, lighting at the site (including public realm lighting and illumination of the ventilation columns), would be barely perceptible in the background of the view. Therefore, the magnitude of change is considered to be negligible.

11.6.55 The negligible magnitude of change, assessed alongside the high sensitivity of the receptor would give rise to a **negligible** effect at night.

Viewpoint 2.7: View east from the northern end of Vauxhall Bridge; and Viewpoint 2.8: View east from the Thames Path at an open space along Millbank

11.6.56 Views from these locations would be affected by the design of the new river wall, above ground structures and CSO interception works. The new structures would form a component of the foreground of the cross-river views, set in front of Camelford House. The proposed development in front of the existing poorly maintained river wall and alongside Vauxhall Bridge, and the introduction of built elements in the currently undeveloped river channel would give rise to adverse effects on these viewpoints.

11.6.57 Due to the foreground visibility of the works, which would be broadly in keeping with the surrounding townscape character, the magnitude of change is considered to be low.

11.6.58 The low magnitude of change, assessed alongside the high sensitivity of these receptors, would result in **minor adverse** effects.

11.6.59 There would be no change to the assessment during summer.

11.6.60 At night, lighting at the site (including public realm lighting and illumination of the ventilation columns), would be barely perceptible in the cross-river view. Therefore, the magnitude of change is considered to be negligible.

11.6.61 The negligible magnitude of change, assessed alongside the high sensitivity of the receptor would give rise to a **negligible** effect at night.

Visual effects – sensitivity test for programme delay

11.6.62 For the assessment of visual effects during operation, a delay to the Thames Tideway Tunnel project of approximately one year would not be likely materially to change the assessment findings reported above (paras. 11.6.29 to 11.6.61). This is on the basis that there are no known schemes within the assessment area that would introduce new visual receptors, or alter visibility of the proposed development from the viewpoints described in paras. 11.4.73 to 11.4.128.

Operational effects Year 15

11.6.63 Operational effects for all townscape and visual receptors identified would remain unchanged in Year 15 compared to Year 1, due to the limited effect any maturing vegetation would have on the visibility of the site and the limited changes anticipated in the surrounding area in the Year 15 base case. This would also apply in the event of a programme delay to the Thames Tideway Tunnel project of approximately one year.

11.7 Cumulative effects assessment

Construction effects

11.7.1 As described in para. 11.3.15, construction of parts of the Battersea Power Station and Embassy Gardens developments would be ongoing during Site Year 2 of construction at the Albert Embankment Foreshore site.

11.7.2 Cumulatively, construction activity associated with all these sites would elevate effects on River Thames – Nine Elms Reach TCA and viewpoints 1.1 and 1.2.

11.7.3 Effects on these receptors, which are considered significant from the Thames Tideway Tunnel development alone (comprising Albert Embankment Foreshore, Kirtling Street, Heathwall Pumping Station and Chelsea Embankment Foreshore in this location) would be elevated and therefore would also be significant when taking into account the Battersea Power Station and Embassy Gardens developments.

11.7.4 This assessment would also apply in the event of a programme delay to the Thames Tideway Tunnel project of approximately one year.

Operational effects

11.7.5 As detailed in the site development schedule (Vol 16 Appendix N) no schemes have been identified within 1km of the site which meet the criteria for inclusion in the cumulative assessment. Therefore no assessment of cumulative effects has been undertaken. This would also apply in the event of a programme delay to the Thames Tideway Tunnel project of approximately one year.

11.8 Mitigation

11.8.1 All measures embedded in the proposed scheme and the *CoCP* of relevance to the townscape and visual assessment are summarised in Section 11.2. No further mitigation is possible for residual effects due to the highly visible nature of the construction activities.

11.8.2 A process of iterative design and assessment has been employed to minimise adverse effects during operation. No further mitigation is possible due to the highly sensitive nature of parts of the townscape and highly visible nature of the proposed development projecting into the river.

11.9 Residual effects assessment

Construction effects

11.9.1 As no mitigation measures are proposed, the residual construction effects remain as described in Section 11.5. All residual effects are presented in Section 11.10.

Operational effects

11.9.2 As no mitigation measures are proposed, the residual operational effects remain as described in Section 11.6. All residual effects are presented in Section 11.10.

11.10 Assessment summary

11.10.1 The assessment has considered both access Options A and B and given that there are not anticipated to be any substantial differences (other than those set out in Vol 16 Table 11.5.1 and Vol 16 Table 11.6.1), the assessment summary table reflects both options.

Vol 16 Table 11.10.1 Townscape – summary of construction assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
The site	Change to character due to removal of structures, installation of hoardings and welfare facilities, construction of the cofferdam, shaft and ventilation equipment and the intensity of construction activity.	Major adverse	No mitigation possible	Major adverse
River Thames – Nine Elms Reach	Change to setting due to the presence of construction activity at Albert Embankment Foreshore, and construction activity, jetty, cofferdam and construction plant at Heathwall Pumping Station and Kirtling Street.	Moderate adverse	No mitigation possible	Moderate adverse
River Thames – Vauxhall and Pimlico Reach	Change to setting due to the presence of construction activity within the river corridor	Major adverse	No mitigation possible	Major adverse
Albert Embankment Commercial	Change to part of the areas setting due to the presence of the site cofferdam, construction activity, construction plant, traffic, site hoardings and welfare facilities.	Moderate adverse	No mitigation possible	Moderate adverse
St George's Wharf Residential	Change to riverside setting due to the presence of the site cofferdam, construction activity and construction plant at Albert Embankment Foreshore and Heathwall Pumping Station, and the river jetty at Kirtling Street.	Moderate adverse	No mitigation possible	Moderate adverse
Nine Elms Lane Residential	Change to wider riverside setting due to construction activity at Albert Embankment Foreshore Heathwall	Moderate adverse	No mitigation	Moderate adverse

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
	Pumping Station and Kirtling Street.		possible	
Residential Waterfront – West	Change to direct riverside setting due to the presence of the site cofferdam, construction activity, construction plant, welfare facilities and CSO interception works.	Major adverse	No mitigation possible	Major adverse
Westminster Residential	Change to part of the areas wider riverside setting due to the presence of the site cofferdam, construction activity, construction plant, welfare facilities and CSO interception works.	Minor adverse	None	Minor adverse
Millbank Conservation Area – Institutional	Change to direct riverside setting due to the presence of the site cofferdam, construction activity, construction plant, welfare facilities and CSO interception works.	Major adverse	No mitigation possible	Major adverse

Vol 16 Table 11.10.2 Visual – summary of construction assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Residential				
Viewpoint 1.1: View northeast and southwest from residences on Nine Elms Lane	Visibility of construction activity, construction plant and 24 loading of barges at Kirtling Street, and the cofferdam at Heathwall Pumping Station. Visibility of construction activity, construction plant and CSO interception works at Albert Embankment Foreshore.	Moderate adverse	No mitigation possible	Moderate adverse
Viewpoint 1.2: View northeast and southwest from residences on Grosvenor Road opposite St George's Square	Visibility of construction activity, construction plant and 24 loading of barges at Kirtling Street, and the cofferdam at Heathwall Pumping Station. Background visibility of the tall construction plant and CSO interception works at Albert Embankment Foreshore.	Moderate adverse	No mitigation possible	Moderate adverse
Viewpoint 1.3: View northeast and southwest from residences on Grosvenor Road near Balvaird Place	Visibility of construction activity, construction plant and 24 loading of barges at Kirtling Street, and the cofferdam at Heathwall Pumping Station. Background visibility of the tall construction plant and CSO interception works at Albert Embankment Foreshore.	Moderate adverse	No mitigation possible	Moderate adverse
Viewpoint 1.4: View southeast from residences at the junction of Ponsonby Place and Causton	Background visibility of tall construction plant and cranes.	Minor adverse	None	Minor adverse

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Street				
Recreational				
Viewpoint 2.1: View south from Lambeth Bridge	Background visibility of the site cofferdam, construction activity, construction plant and welfare facilities.	Minor adverse	None	Minor adverse
Viewpoint 2.2: View south from the Thames Path at the southern end of Lambeth Bridge	Background visibility of the site cofferdam, construction activity, construction plant and welfare facilities, partially obscured by a foreground river pier.	Minor adverse	None	Minor adverse
Viewpoint 2.3: View southwest from the Thames Path opposite Park Plaza	Background visibility of the site cofferdam, construction activity, construction plant and welfare facilities.	Moderate adverse	No mitigation possible	Moderate adverse
Viewpoint 2.4: View southwest from the Thames Path outside Peninsula Heights	Foreground visibility of the site cofferdam, construction activity, construction plant, welfare facilities and site hoardings.	Major adverse	No mitigation possible	Major adverse
Viewpoint 2.5: View northeast from the southern end of Vauxhall Bridge	Foreground visibility of the site cofferdam, construction activity, construction plant, welfare facilities and site hoardings.	Major adverse	No mitigation possible	Major adverse
Viewpoint 2.6: View northeast from the Thames Path south of St George's Wharf	Visibility of construction activity, construction plant and interception works at Albert Embankment Foreshore. Visibility of construction at Heathwall Pumping Station and Kirtling Street.	Moderate adverse	No mitigation possible	Moderate adverse
Viewpoint 2.7: View east from the northern end of Vauxhall Bridge	Visibility of the site cofferdam, construction activity, construction plant and welfare facilities in the direct cross-river view.	Major adverse	No mitigation possible	Major adverse

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Viewpoint 2.8: View east from the Thames Path at an open space along Millbank	Visibility of the site cofferdam, construction activity, construction plant and welfare facilities in the direct cross-river view.	Major adverse	No mitigation possible	Major adverse
Viewpoint 2.9: View southeast from the north end of Atterbury Street	No significant effects.	Negligible	None	Negligible
Viewpoint 2.10: View southeast from the entrance to Tate Britain	Heavily screened visibility of the site cofferdam, construction activity, construction plant and welfare facilities.	Minor adverse	None	Minor adverse

Vol 16 Table 11.10.3 Townscape – summary of Year 1 and Year 15 operational assessment[i]

Receptor[ii]	Effect	Significance of effect	Mitigation	Significance of residual effect
The site	Change in character through creation of new public realm and well-designed above ground structures.	Moderate beneficial	None	Moderate beneficial
River Thames – Nine Elms Reach	Change in setting due to the interception works underneath Vauxhall Bridge, creation of a new public frontage along the river at Heathwall Pumping Station and demolition of dilapidated buildings at Kirtling Street.	Minor beneficial	None	Minor beneficial
River Thames – Vauxhall and Pimlico Reach	Change to setting through the introduction of a new foreshore structure and above ground structures in a previously undeveloped part of the river.	Minor adverse	None	Minor adverse
Albert Embankment Commercial	Change to setting through creation of new public realm and well-designed above ground structures.	Minor beneficial	None	Minor beneficial
St George's Wharf Residential	Slight change in setting due to the interception works underneath Vauxhall Bridge.	Negligible	None	Negligible
Residential Waterfront – West	Change to setting through the introduction of a new foreshore structure and above ground structures in a previously undeveloped part of the river.	Minor adverse	None	Minor adverse
Millbank Conservation Area – Institutional	Change to setting through the introduction of a new foreshore structure and above ground structures in a previously undeveloped part of the river.	Minor adverse	None	Minor adverse

[i] Operational effects have been assessed to be the same in both Year 1 and Year 15 of operation

[ii] Townscape character areas not assessed during operation (refer to para. 11.6.7) are not included in the summary table

Vol 16 Table 11.10.4 Visual – summary of Year 1 and Year 15 operational assessment[iii]

Receptor[iv]	Effect	Significance of effect	Mitigation	Significance of residual effect
Recreational				
Viewpoint 2.1: View south from Lambeth Bridge	Background visibility of the proposed development.	Winter – Negligible	Winter – None	Winter – Negligible
		Summer – Negligible	Summer – None	Summer - Negligible
	At night, lighting would be barely perceptible.	Negligible	None	Negligible
Viewpoint 2.3: View southwest from the Thames Path opposite Park Plaza	Background visibility of the new river wall, above ground structures and public realm set in front of Vauxhall Bridge (Grade II* listed).	Winter – Minor adverse	Winter – None	Winter – Minor adverse
		Summer – Negligible	Summer – None	Summer – Negligible
	At night, lighting would be barely perceptible.	Negligible	None	Negligible
Viewpoint 2.4: View southwest from the Thames Path outside Peninsula Heights	Foreground visibility of the new river wall, above ground structures and public realm.	Winter – Moderate beneficial	Winter – None	Winter – Moderate beneficial
		Summer – Moderate	Summer – None	Summer – Moderate

[iii] Operational effects have been assessed to be the same in both Year 1 and Year 15 of operation

[iv] Viewpoints not assessed during operation (refer to para. 11.6.21) are not included in the summary table

Receptor[iv]	Effect	Significance of effect	Mitigation	Significance of residual effect
		beneficial		beneficial
	At night, lighting would be noticeable but set amongst a brightly lit context.	Negligible	None	Negligible
Viewpoint 2.5: View northeast from the southern end of Vauxhall Bridge	Foreground visibility of the new river wall, above ground structures and public realm.	Winter – Moderate beneficial	Winter – None	Winter – Moderate beneficial
		Summer – Moderate beneficial	Summer – None	Summer – Moderate beneficial
	At night, lighting would be noticeable but set amongst a brightly lit context.	Negligible	None	Negligible
Viewpoint 2.6: View northeast and southwest from the Thames Path south of St George's Wharf	Visibility of the interception works underneath Vauxhall Bridge.	Winter – Negligible	Winter – None	Winter – Negligible
		Summer – Negligible	Summer – None	Summer – Negligible
	At night, lighting would be barely perceptible.	Negligible	None	Negligible
Viewpoint 2.7: View east from the northern end of Vauxhall Bridge	Visibility of the new river wall (set in front of the existing poorly maintained river wall), above ground structures and CSO interception works.	Winter – Minor adverse	Winter – None	Winter – Minor adverse
		Summer – Minor adverse	Summer – None	Summer – Minor adverse
	At night, lighting would be barely perceptible.	Negligible	None	Negligible

Receptor[iv]	Effect	Significance of effect	Mitigation	Significance of residual effect
Viewpoint 2.8: View east from the Thames Path at an open space along Millbank	Visibility of the new river wall (set in front of the existing poorly maintained river wall), above ground structures and CSO interception works.	Winter – Minor adverse	Winter – None	Winter – Minor adverse
		Summer – Minor adverse	Summer – None	Summer – Minor adverse
	At night, lighting would be barely perceptible.	Negligible	None	Negligible

References

[1] Department of Environment, Food and Rural Affairs (Defra). *National Policy Statement for Waste Water.* (2012)..

[2] LB of Lambeth. *LDF Core Strategy* (January 2011).

[3] LB of Wandsworth. *LDF Core Strategy* (October 2010).

[4] Westminster City Council. *LDF Core Strategy* (January 2011).

[5] LB of Lambeth. *Conservation Area Designation Reports* (no date).

[6] Westminster City Council. *Conservation Area Information Leaflets* (May 2004).

[7] Defra. (2012). See citation above.

Thames Tideway Tunnel
Thames Water Utilities Limited

Thames Water

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.16**

Volume 16: Albert Embankment Foreshore site assessment

Section 12: Transport

APFP Regulations 2009: Regulation **5(2)(a)**

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Creating a cleaner, healthier River Thames

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Thames Tideway Tunnel

Environmental Statement

Volume 16: Albert Embankment Foreshore site assessment

Section 12: Transport

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12 Transport

12.1 Introduction

12.1.1 This section presents the findings of the assessment of the likely significant transport effects of the proposed development at the Albert Embankment Foreshore site. The project-wide transport effects are described in Volume 3 Project-wide effects assessment.

12.1.2 Construction of the proposed development at the site has the potential to affect the following transport elements:

a. pedestrian routes

b. cycle routes

c. bus routes and patronage

d. London Underground and National Rail services

e. river passenger services and river navigation

f. car and coach parking

g. highway layout, operation and capacity.

12.1.3 The assessment considers the effects on each of these elements during construction, as well as effects on specific receptors including nearby residents and users/occupiers of nearby businesses and recreational spaces.

12.1.4 The operation of the Albert Embankment Foreshore site has the potential to affect pedestrians and highway layout and operation and therefore effects on these are considered within the operational assessment.

12.1.5 The assessment of transport presented in this section has considered the requirements of the National Policy Statement for Waste Water (Defra, 2012)[1] section 4.13. Further details of these requirements can be found in Vol 2 Section 12.3.

12.1.6 Additionally, a separate *Transport Assessment* has been produced which provides an assessment of the effects on the transport network as a result of the construction and operational phases at the Albert Embankment Foreshore site. The *Transport Assessment* accompanies application for development consent (the ‘application’).

12.1.7 Plans of the proposed development as well as figures included in the assessment for this site are contained in a separate volume (Volume 16 Albert Embankment Foreshore Figures).

12.1.8 The separate but related assessments of effects of transport on air quality and noise and vibration are contained in Sections 4 and 9 respectively.

12.2 Proposed development relevant to transport

12.2.1 The proposed development is described in Section 3 of this volume. The elements of the proposed development relevant to transport are set out below.

Construction

12.2.2 The construction site would be located on the foreshore of the River Thames; The majority of the site (the main site) lies to the northeast of the bridge with a smaller area located under the bridge and to the southwest. In order to provide working areas the site would also occupy part of the riverside footway.

12.2.3 Two construction access strategies are being considered for this site:

a. Option A (single access option) - all vehicle access to and from the main site would take place from the nearside lane of the northbound carriageway of Albert Embankment (A3036) via a newly constructed access road adjacent to the existing Lacks Dock slipway. Access to the river foreshore via Lacks Dock would be necessary to provide occasional access to the foreshore site for plant/machinery.

b. Option B (dual access option) - construction vehicle access to and from the main site would take place from the nearside lane of the northbound carriageway of Albert Embankment (A3036) via a newly constructed access road between Camelford House and Tintagel House. Occasional access for vehicles carrying large construction plant/machinery would be via the existing Lacks Dock slipway (as described in a. above).

12.2.4 During construction it is anticipated that the elements listed under para. 12.1.2 may be affected as a result of the additional construction traffic associated with the Albert Embankment Foreshore site and other Thames Tideway Tunnel project construction sites with construction routes along Albert Embankment (A3036) as well as pedestrian diversions along the Thames Path and permanent suspension of car parking bays (Option B only).

12.2.5 Details of the peak year of construction, anticipated lorry and barge movements and the activities which would generate these movements are provided in Vol 16 Table 12.2.1.

Vol 16 Table 12.2.1 Transport - construction details

Description	Assumption
Assumed peak period of construction lorry movements	Site Year 1 of construction
Assumed average peak daily construction lorry vehicle movements (in peak month of Site Year 1 of construction)	46 movements per day (23 vehicle trips)
Assumed peak period of construction barge movements	Site Year 1 of construction
Assumed average peak daily construction barge movements (in peak month of Site Year 1 of construction)	8 movements per day (4 barge trips)
Typical types of lorry requiring access (comprising rigid-bodied, flatbed and articulated vehicles)	Imported fill lorries Aggregate lorries Cement tankers lorries Ready mix mixer lorries Steel reinforcement lorries Tunnel precast concrete linings lorries Office delivery lorries Plant and equipment lorries Temporary construction material lorries including pipe/track/oils/greases lorries Excavation lorries

Note: a movement is a construction vehicle/barge moving either to or from a site. A Site Year is a 12 month period, one in a series of Site Years; Site Year 1 commences at the start of construction.

12.2.6 During construction cofferdam fill (both import and export) and shaft and other excavated material (export) would be transported by barge. For the transport assessment is has been assumed that 90% of these materials are taken by river. This allows for periods that the river is unavailable or material is unsuitable for river transport. All other material would be transported by road.

12.2.7 Vehicle movements would take place during the standard day shift of ten hours on weekdays (08:00 to 18:00) and five hours on Saturdays (08:00 to 13:00). It would only be in exceptional circumstances that HGV and abnormal load movements could occur up to 22:00 on weekdays for large concrete pours and later at night by agreement with the London Borough (LB) of Lambeth.

Construction traffic routing

12.2.8 The access plan and highway layout during construction plans (see separate volume of figures – Section 1) present the highway layout during construction of Option A and Option B.

12.2.9 The Albert Embankment Foreshore site is located on the Transport for London Road Network (TLRN) on Albert Embankment (A3036) approximately 130m north of the Vauxhall Gyratory.

12.2.10 Construction traffic routing to the site from the east along Camberwell New Road / Peckham Road (A202) or from the south along Clapham Road (A3) would route through the Vauxhall Gyratory and then north along Albert Embankment (A3036) to the site access point(s). Vehicle access would be arranged on a left-turn in, left-turn out basis.

12.2.11 Vehicles leaving the site would route north to the roundabout with Lambeth Road (A3203) at the east end of Lambeth Bridge. Vehicles would then either travel back south along Albert Embankment (A3036) to the Vauxhall Gyratory or east along Lambeth Road (A3203) towards the Elephant and Castle interchange on the A3.

12.2.12 The existing Lacks Dock access and slipway from Albert Embankment (A3036) is currently used by the commercial tour company Duck Tours which uses amphibious vehicles. The access would remain open to use by Duck Tours during construction.

12.2.13 The alternative access option between Camelford House and Tintagel House routes through a section of the Tintagel House car park and the ramp to the Camelford House underground car park. Access to the underground car park would be maintained during construction. If this option were adopted, this access would be used by the majority of construction vehicles and the access at Lacks Dock would be used occasionally by vehicles transporting large construction plant/machinery.

12.2.14 Vol 16 Figure 12.2.1 (see separate volume of figures) shows the construction traffic routes for access to/from the Albert Embankment Foreshore site. Construction routes have been discussed with both Transport for London (TfL) and the LB of Lambeth for the purposes of the assessment.

Construction workers

12.2.15 The construction site is expected to require a maximum workforce of approximately 65 workers at any one time. The number and type of workers is shown in Vol 16 Table 12.2.2.

Vol 16 Table 12.2.2 Transport - construction worker numbers

Contractor				Client	
Staff*		Labour**		Staff***	
08:00-18:00	18:00-08:00	08:00-18:00	19:00-07:00	08:00-18:00	18:00-08:00
30	0	25	0	10	0

** Staff Contractor – engineering and support staff to direct and project manage the engineering work on site.*
*** Labour – those working on site doing engineering, construction and manual work.*
**** Staff Client – engineering and support staff managing the project and supervising the Contractor*

12.2.16 At the Albert Embankment Foreshore site there would be no parking provided within the site boundary for workers. As parking on surrounding streets is also restricted, and measures to reduce car use would be incorporated into site-specific *Travel Plan* requirements (in accordance with the overall aims and objectives of the *Draft Project Framework Travel Plan*), it is highly unlikely that workers would travel by car. It is therefore assumed that construction workers would access the site by other modes of transport, further details of which are provided in Vol 16 Table 12.5.1.

Code of Construction Practice

12.2.17 Measures incorporated into the *Code of Construction Practice (CoCP)*[i] *Part A* (Section 5) to reduce transport effects include:

a. site specific *Traffic Management Plans* (*TMP*): to set out how vehicular access to the site would be managed so as to minimise impact on the local area and communicate this with the local borough and other stakeholders. This includes any works on the highway, diversion or temporary closure of the highway or public right of way

b. HGV management and control: to ensure construction vehicles use appropriate routes to the sites and the vehicle fleet and/or drivers meet current safety and environmental standards

c. site specific *River Transport Management Plans* (*RTMP*) are to be produced for each relevant worksite. As with the *TMP*'s this would set out how river access to site would be managed so as to minimise impact on the river and communicate this with the PLA, local borough and other stakeholders

[i] The *Code of Construction Practice (CoCP)* is provided in Vol 1 Appendix A. It contains general requirements (Part A), and site specific requirements for this site (Part B).

12.2.18 In addition to the general measures within the *CoCP Part A*, the *CoCP Part B* (Section 5) relating to the Albert Embankment Foreshore site includes the following measures:

a. access to the site would be from Vauxhall Gyratory and Albert Embankment (A3036). The new site access road is adjacent to Lacks Dock.

b. access for to Lacks Dock for Duck Tours would be maintained throughout the works unless agreed otherwise

c. Option A: the existing security kiosk at Lacks Dock would be relocated and be utilised for a tandem Thames Tideway Tunnel project site access and Duck Tours access security

d. Option B: the new site access road is between Camelford House and Tintagel House, with a new crossover constructed in the pavement

e. Options A and B: vehicles would turn left in and turn left out only and exit northbound along Albert Embankment (A3036)

f. the security barrier would be positioned at the entrance to the site access road(s) to allow a standard rigid tipper vehicle to be wholly off Albert Embankment (A3036) whilst awaiting barrier operation

g. drivers of construction vehicles accessing the site would be required to obtain security clearance before arriving at the site. The method of obtaining security clearance is to be confirmed. Vehicles arriving at the site entrance without clearance to access the site would be denied entry. Vehicles denied entry would leave the site via a left turn onto Albert Embankment (A3036) under the supervision of a traffic marshal to prevent conflict with other road users on Albert Embankment (A3036) or vehicles entering Lacks Dock or Camelford House vehicle entrance. Large vehicles denied access that are unable to turn off the highway would reverse onto Albert Embankment (A3036) under the supervision of a traffic marshal

h. Option A: a traffic marshal would be stationed at the site entrance to manage potential conflicting movements (eg, with incoming/outgoing Duck Tours vehicles) and ensure no vehicles queue/wait on Albert Embankment (A3036)

i. drivers of large vehicles exiting the site would be made aware that the vehicle may encroach into the offside northbound lane

j. provision of signage for pedestrian diversions (Thames Path) would clearly identify alternative routes during the construction works at the Albert Embankment Foreshore site

k. areas of foreshore between the working areas would have suitable protection placed for vehicle transport such as concrete ‘armorloc’ or similar product.

12.2.19 The effective implementation of the *CoCP Part A* and *Part B* measures is assumed within the assessment.

12.2.20 Based on current travel planning guidance including TfL's 'Travel Planning for new development in London' (TfL, 2011)[2], this development falls within the threshold for producing a Strategic Framework Travel Plan. A *Draft Project Framework Travel Plan* has been prepared based on the TfL ATTrBuTE guidance (TfL, 2011)[3]; and accompanies the application. The *Draft Project Framework Travel Plan* addresses project-wide travel planning measures including the need for a project-wide Travel Plan Manager, initial travel surveys during construction and a monitoring framework. It also contains requirements and guidelines for the site-specific *Travel Plans* to be prepared by the site contractors. The site-specific travel planning requirements of relevance to the *Draft Project Framework Travel Plan* are as follows:

a. information on existing transport networks and travel initiatives for the Albert Embankment Foreshore site

b. a mode split established for the Albert Embankment Foreshore site construction workers to establish and monitor travel patterns

c. site-specific targets and interim targets would be established based on the mode share which would link to objectives based on local, regional and national policy

d. a nominated person with responsibility for managing the *Travel Plan* monitoring and action plans specifically for this site.

Other measures during construction

12.2.21 Embedded design measures which are not outlined in the *CoCP* but are of relevance to the transport assessment at the Albert Embankment Foreshore site include the following:

a. realignment of the northern kerb at the site access (Option A only)

b. minimum of 3m width traffic lanes to be retained

c. removal of a section of the low wall (which segregates the Duck Tour access route on Lacks Dock from the Thames Path adjacent to Camelford House to accommodate the construction access road)

d. if the alternative site access between Camelford House and Tintagel House is implemented (Option B) a new access would be required from Albert Embankment (A3036) and the level of the Tintagel House car park would need to be aligned with the existing carriageway and footway. Also, the ramp to the Camelford House underground car park would be reduced to a single lane with traffic flow regulated by a traffic light system at the top and bottom of the ramp.

Operation

12.2.22 A new public realm area would be created in the foreshore to the west of Camelford House and the Vauxhall Cross, effectively widening the Thames Path at this location. These areas would include seating with views over the River Thames.

12.2.23 During operation, maintenance vehicles would enter the site from the northbound carriageway of Albert Embankment (A3036), as set out in the Albert Embankment Foreshore design principles (see *Design Principles* report Section 4.13 in Vol 1 Appendix B). Access would be required for a light commercial vehicle on a three to six monthly maintenance schedule. Additionally there would be more sustantive maintenance visits at approximately ten year intervals which would require access to enable two mobile cranes and associated support vehicles to be brought to the site. Maintenance visits may require the temporary closure of the Thames Path in the vicinity of the site and the foreshore access via Lacks Dock.

12.3 Assessment methodology

Engagement

12.3.1 Volume 2 Environmental assessment methodology documents the overall engagement which has been undertaken in preparing the *Environmental Statement*. Specific comments relevant to this site for the assessment of traffic and transport are presented in Vol 16 Table 12.3.1.

12.3.2 It is noted that it was reported in the *Scoping Report* that operational traffic effects for the project as a whole were scoped out of the environmental impact assessment (EIA). However, while the environmental effects associated with transport for the operational phase are not expected to be significant or adverse, the assessment of transport effects in the *Environmental Statement* examines relevant aspects of the operational phase in order to satisfy the relevant stakeholders that technical issues have been addressed.

Vol 16 Table 12.3.1 Transport – stakeholder engagement

Organisation	Comment	Response
Transport for London, Transport Assessment workshop, November 2012	The layouts of Access Options A and B do not appear to have been finalised.	Both access layouts have been submitted within the application documentation, with both options assessed in Section 12.5.
Transport for London, Transport Assessment workshop, November 2012	Construction vehicles being refused entry and reversing back onto the Albert Embankment will be through a bus lane into oncoming traffic.	It is not possible for vehicle turning to be managed on site. Any reversing movements onto Albert Embankment (A3036) would be marshalled and managed.
Transport for London, Transport Assessment	Information on construction traffic	OmniTrans plots showing Thames Tideway Tunnel

Organisation	Comment	Response
workshop, November 2012	associated with other Thames Tideway Tunnel project sites has not been provided for review. Flow distribution diagrams covering a wider area are required	project construction traffic for wider area are included in the project-wide *Transport Assessment*.
Transport for London, phase two consultation, February 2012	The construction impact must not impede the operation of the SRN/TLRN.	TfL have been consulted with regard to modelling and analysis. Local modelling outcomes showing the effects on the operation of the SRN and TLRN are reported in Section 12.5. A project-wide assessment is contained in Vol 3.
LB of Lambeth, targeted consultation, January 2012	The Borough states that the location of the access on Albert Embankment (A3036) at Lacks Dock is not an issue and for TfL to be consulted to confirm they are also happy.	TfL have been consulted and are satisfied with the location of this access providing sufficient traffic management is implemented to ensure vehicles attempting to enter the site can do so without needing to wait on the carriageway and also that if it is necessary for vehicles to reverse onto Albert Embankment (A3036) that they do so under supervision. These measures are included in the *CoCP* Part B for the Albert Embankment Foreshore site.
LB of Lambeth, targeted consultation, January 2012	The Borough has no concerns over TfL's suggestion that vehicles arriving at the site which are refused entry would reverse onto Albert Embankment (A3036) under supervision.	Noted.
LB of Lambeth, targeted consultation, January 2012	The Borough acknowledges that the Albert Embankment Foreshore site may require a vehicle holding or screening area and	Location of the vehicle holding area is to be identified and agreed with LB Lambeth and TfL in due course.

Organisation	Comment	Response
	suggests the area adjacent to Kennington Oval and the road under the railway line at Vauxhall Gyratory as suitable potential locations for the holding area. The Borough is content that the precise location will not be identified until closer to the construction start date.	
LB of Lambeth, targeted consultation, January 2012	The Borough indicates a preference to avoid vehicles 'stacking' (queuing) at site access or convoys of vehicles entering the site. The Borough is content that the security screening will help to manage lorry flow into the site to alleviate multiple HGVs and potential queuing.	Construction vehicle flows would be managed to avoid queuing at the site access. Control measures are detailed in the *CoCP* Part B (Section 5).
LB of Lambeth, targeted consultation, January 2012	The Borough would not welcome a considerable amount of new signage for diversions.	Signage would be kept to an appropriate level of provision. This is addressed through the *CoCP* (Section 5).
LB of Lambeth, targeted consultation, January 2012	The Thames Path diversion is to be signposted and safety issues taken into account. It is agreed that the footway on Albert Embankment (A3036) has adequate capacity to accommodate the diversion.	A diversion to the Thames Path would be required and is considered in the assessment. This would be appropriately signposted.
LB of Lambeth, targeted consultation, January 2012	The Borough is satisfied with the approach taken to modelling and the scale of the likely impacts.	Noted.
LB of Lambeth, targeted consultation, January 2012	The Borough is concerned about the impact in Lambeth as a result of the works at the Blackfriars	This has been taken into consideration within the project-wide assessment (Vol 3).

Organisation	Comment	Response
	Bridge Foreshore site and would like to be kept appraised of the situation. This concern is based upon transport impacts borne out of CTRL experience and congestion at Waterloo.	
LB of Lambeth, scoping response, June 2011	The Borough requests that the EIA sets out how any negative impacts on Albert Embankment Gardens, in relation to pedestrian movement, would be minimised.	The assessment considers the effects on pedestrian movements in the area including on Albert Embankment Gardens which is a receptor in the transport assessment (see Section 12.5).
LB of Lambeth, scoping response, June 2011	A *Service Management Plan* (for construction traffic) will be required and should provide details of the management of vehicles and deliveries.	The *CoCP* Part B (Section 5) details measures for the management of vehicles and deliveries.
LB of Lambeth, scoping response, June 2011	A *Travel Strategy* for construction workers should be included in draft in the TA.	A *Draft Project Framework Travel Plan* has been prepared based on the TfL ATTrBuTE guidance. The *CoCP* Part A (Section 5) addresses project-wide travel planning measures and *CoCP* Part B (Section 5) addresses site-specific measures.
Transport for London, consultation workshop, June 2011	Regarding construction vehicles refused entry at the site entrance; given the effects that would arise from the creation of an off-highway vehicle turning area and given the likely infrequency at which vehicles would be refused entry it would be acceptable for these vehicles to reverse back onto Albert Embankment (A3036) providing sufficient traffic management measures	Traffic management measures to ensure the safety of pedestrians and road users if vehicles are required to undertake this reversing movement are contained in the *CoCP* Part B (Section 5) and would include the use of traffic marshals. In addition, measures would be implemented to prevent legitimate construction vehicles being refused entry, for example establishing radio contact between site marshals, vehicle drivers and

Organisation	Comment	Response
	are implemented	the vehicle holding area/s.
Transport for London, consultation workshop, June 2011	The location of the vehicle holding security area must be identified within the DCO planning submission.	The location vehicle holding security area will be identified at a later date and will be subject to a separate consent.
LB of Lambeth, consultation workshop, April 2011	The application will need to be accompanied by a *Transport Assessment* that addresses impacts on Albert Embankment and Vauxhall Gyratory and on the quality of walking and cycling routes in the area.	The assessment considers the effects on highways, pedestrian and cycle routes in the area including Albert Embankment (A3036) and Vauxhall Cross. This is reported in Section 12.5.
LB of Lambeth, consultation workshop, April 2011	Large crowds are likely at Vauxhall Gyratory on New Year's Eve. The impact of construction activity on these crowds must be considered.	The interface between construction activity and pedestrian movements would be managed through the *CoCP* (Section 5).
LB of Lambeth, consultation workshop, April 2011	The Battersea Power Station proposals and Northern Line extension need to be considered in the TA.	These developments are taken into consideration within the assessment.
LB of Lambeth, phase one consultation, December 2010	The use of the river for construction traffic [sic] should be maximised.	The *Transport Strategy* sets out the proposals to transport cofferdam fill (import and export), shaft and other excavated material (export). For assessment purposes, it has been assumed that 90% of these materials are taken by river.

Baseline

12.3.3 The baseline methodology follows the methodology described in Vol 2. There are no site specific variations for identifying the baseline conditions for this site.

Construction

12.3.4 The assessment methodology for the construction phase follows that described in Vol 2 with the exception of the method of local capacity modelling. Due to the number of committed developments in the Nine Elms area the base case traffic flows in the TfL HAMs are lower than the expected flows. Background traffic flows have therefore been calculated using information available for each committed development site and manually adding these into the models as described further in para. 12.3.9 below.

12.3.5 The effect of all other Thames Tideway Tunnel project sites on the area surrounding Albert Embankment Foreshore site has been taken into account within the assessment of the peak year of construction at this site.

12.3.6 As indicated in the site development schedule (see Vol 16 Appendix N) a number of developments would be complete and operational by Site Year 1 of construction. These developments have been included in the construction base case (except where information has not been available). Developments that will be complete and operational are:

a. Market Towers
b. Spring Mews, Vauxhall[i]
c. 2-14 Tinworth Street and 108-110 Vauxhall Walk
d. Eastbury House, 30-34 Albert Embankment
e. Riverwalk House, Millbank
f. 1-9 Bondway and 4-6 South Lambeth Place
g. St George's Wharf (Vauxhall Tower)
h. Hampton House, 20 Albert Embankment
i. 30-60 South Lambeth Road
j. 10 Albert Embankment (Wah Kwong House)
k. 8 Albert Embankment and land to rear
l. 81 Black Prince Road (Parliament House)
m. Vauxhall Sky Gardens, Wandsworth Road
n. US Embassy site, Ponton Road
o. Nine Elms Sainsburys, Wandsworth Road
p. Embassy Gardens (Buildings A09, A10 and A11)
q. 10 Pascal Street
r. New Covent Garden Market (Buildings B4-B6)[i]

12.3.7 There will also be some developments that will be under construction at the same time as construction works at the Albert Embankment Foreshore site. These are:

a. Vauxhall Square Cap Gemini (plot bounded by Parry Street, Bondway, Miles Street and Wandsworth Road)
b. Island Site, Vauxhall Gyratory
c. Embassy Gardens (Buildings A01A05, and A07)
d. Nine Elms Parkside, Nine Elms Lane

e. Battersea Power Station, Nine Elms Lane[ii]

f. Northern Line Extension

g. Riverlight development[i]

h. New Covent Garden Market (Buildings B1-B3 and site entrance)[i]

12.3.8 This means that there are also cumulative effects to consider.

12.3.9 While the TfL Highway Assignment Models (HAMs) which have been used in the transport assessment have been developed by TfL using GLA employment and population forecasts (based on the employment and housing projections set out in the *London Plan 2011* [GLA, 2011][4]), the level of traffic growth assumed for these developments in the model is considered to be lower than would actually be expected. Base case traffic has therefore been calculated by using the net vehicular trip generation of these development sites and adding them to the baseline traffic survey flows, as described in the *Transport Assessment*. This approach has been agreed with TfL, although it is noted that the traffic generation assumptions are likely to change in future as the Northern line Extension proposals are developed in more detail. Given the information currently available it is assumed that trips associated with the other developments outlined within the site development schedule (see Vol 16 Appendix N – both those under construction and complete and operational) are taken into account within the traffic modelling.

12.3.10 Due to the proximity to the Kirtling Street site, the vehicular trip generation for the developments in the base case for the Albert Embankment Foreshore site have been based on the peak construction year for Kirtling Street, as there are a higher number of vehicles predicted in this year than Site Year 1 at Albert Embankment Foreshore. Hence using the generated trips for 2019 provides a robust assessment at Albert Embankment Foreshore site.

Construction assessment area

12.3.11 The assessment area for the Albert Embankment Foreshore site includes the two possible site accesses and the footways, cycleways and roads in the immediate vicinity.

12.3.12 The Lacks Dock junction (Option A) as well as the new access at Tintagel House junction (Option B) with Albert Embankment (A3036) have been assessed for highway, cycle and pedestrian impacts. The Thames Path has also been included within the assessment due to its proximity to the development site. Additionally, effects on local bus services within 640m of the site and rail services within 960m of the site have been assessed[iii].

Construction assessment years

12.3.13 A site-specific peak construction assessment year has been identified. The histograms in Vol 16 Plate 12.3.1 and Vol 16 Plate 12.3.2 show that

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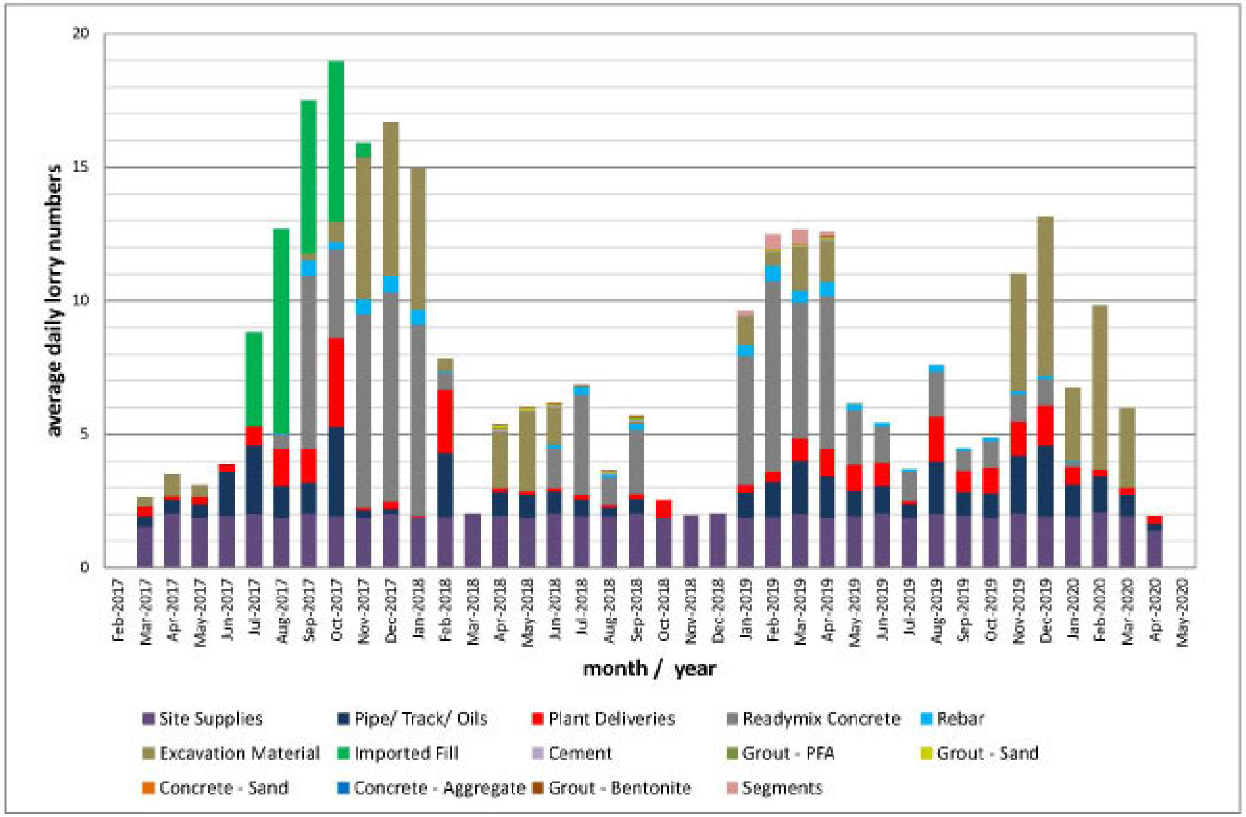
[ii] These sites have been identified in liaison with TfL and LB of Wandsworth, which are in addition to those indicated in the site development schedule (see Vol 16 Appendix N)

[iii] Distances derived from the Public Transport Accessibility Level (PTAL) methodology described in Vol 2.

the peak site-specific activity at the Albert Embankment Foreshore site would occur in Site Year 1 of construction for both construction traffic and construction barge movements.

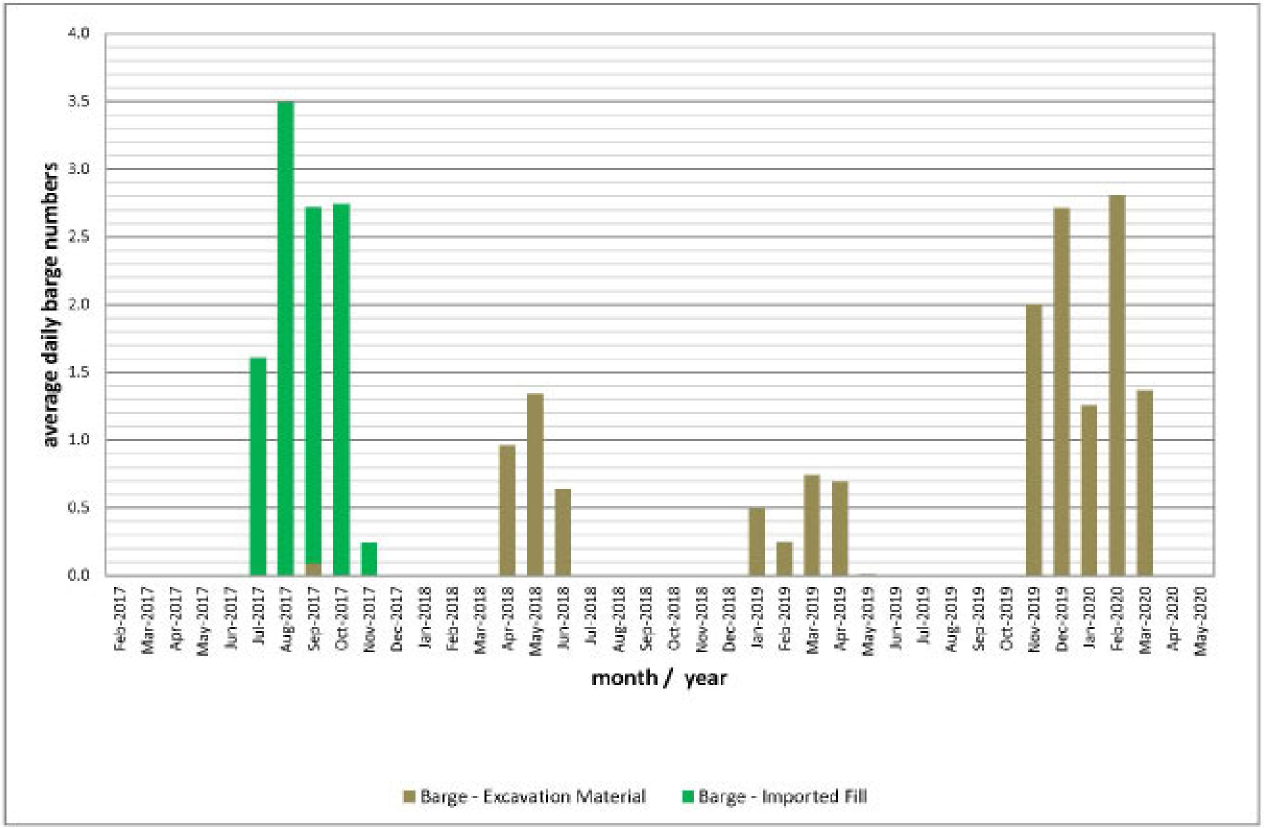
12.3.14 The assessment of construction effects also considers the extent to which the assessment findings would be likely to be materially different should the programme for the Thames Tideway Tunnel project be delayed by approximately one year.

Vol 16 Plate 12.3.1 Transport – estimated construction lorry profile



Note: Plate shows approximate volumes and number of lorry trips based upon assumed timings for the works. It is not a programme and remains subject to change.

Vol 16 Plate 12.3.2 Transport – estimated construction barge profile



Note: Plate shows approximate volumes and number of barge trips based upon assumed timings for the works. It is not a programme and remains subject to change.

Operation

12.3.15 The assessment methodology for the operational phase follows that described in Vol 2. There are no site-specific variations for undertaking the operational assessment of this site.

12.3.16 Once the Thames Tideway Tunnel is operational, it is not expected that there would be any significant effects on the transport infrastructure and operation within the local area because maintenance trips to the site would be infrequent and short-term. On this basis it is not necessary to assess the effects on all the elements listed at para. 12.1.2. The only elements considered are:

a. effects on pedestrians

b. effects on highway operation.

12.3.17 These elements are considered qualitatively (as described in Vol 2) because the minimal effect on the highway network means that a quantitative assessment is not required. The scope of this analysis has been agreed with the LB of Lambeth and TfL.

12.3.18 Also, given the local impact of transport activity during the operational phase only the localised transport effects around the Albert Embankment Foreshore site have been considered in this assessment. Other Thames Tideway Tunnel project sites would not affect the area around the site in the operational phase and therefore it is not necessary to consider them in the assessment.

12.3.19 With regard to other developments in the vicinity of the site (as detailed in Vol 16 Appendix N), the developments listed in paras. 12.3.6 and 12.3.7 would all be complete and operational by Year 1 of operation of the Albert Embankment Foreshore site with the exception of the Nine Elms Parkside, Battersea Power Station and New Covent Garden Market developments. Those completed and operational developments have been included within the operational base case.

12.3.20 Development at Nine Elms Parkside would be partially complete and occupied with construction continuing on the remainder of the development in Year 1 of operation at the Albert Embankment Foreshore site. Development at Battersea Power Station and New Covent Garden Market would also still be under construction at this time. This suggests that the transport assessment should consider cumulative effects in the operational phase. However, as para. 12.3.9 explains, the assessment inherently takes into account a level of future growth and development across London which is based on GLA employment and population forecasts.

Operational assessment area

12.3.21 The assessment area for the operational assessment remains the same as for the construction assessment as set out in paras. 12.3.11-12.3.20.

Operational assessment year

12.3.22 As outlined in Vol 2 the operational assessment year has been taken as Year 1 of operation. As the number of vehicle movements associated with the operational phase is low there is no requirement to assess any other year beyond that date.

12.3.23 As with construction, the assessment of operational effects also considers the extent to which the assessment findings would be likely to be materially different should the programme for the Thames Tideway Tunnel project (and hence opening year) be delayed by approximately one year.

Assumptions and limitations

12.3.24 The general assumptions and limitations associated with this assessment are presented in Vol 2.

Assumptions

12.3.25 While Tintagel House is currently unoccupied, for the purpose of this assessment, Tintagel House is assumed to be occupied by Site Year 1 of construction as this enables the maximum effects of the Thames Tideway Tunnel project at the Albert Embankment Foreshore site to be assessed.

12.3.26 Local junction modelling for the construction base and development cases at this site has incorporated traffic signal optimisation on the basis that this would be implemented as necessary by TfL (as part of routine management) to ensure the effective operation of the highway network and respond to changes in traffic conditions.

12.3.27 There would be deliveries of fuel for construction plant at this site and a number of construction products may be classified as hazardous. For the Albert Embankment Foreshore site, it is assumed that there would be one hazardous load per fortnight generated by the site.

12.3.28 With regard to construction workers travelling to the site, it is assumed that no construction workers would drive to the site, as set out in para. 12.5.4.

Limitations

12.3.29 There are no site-specific limitations of the transport assessment undertaken for this site.

12.4 Baseline conditions

12.4.1 The following section sets out the baseline conditions for transport within and around the site. Future baseline conditions (base case) are also described.

Current baseline

12.4.2 As shown in Vol 16 Figure 12.4.1 (see separate volume of figure) there is an existing road access junction on Albert Embankment (A3036), one of the proposed site access points. This junction currently operates as access to the Lacks Dock slipway and Camelford House with separate accesses to both. This junction currently provides for both left and right turning movements into and out of the site. There is no existing road access to Tintagel House/Camelford House off Albert Embankment (A3036) where the newly constructed access road would be located (in Option B).

Pedestrian routes

12.4.3 The existing pedestrian network and facilities in the vicinity of the site are shown in Vol 16 Figure 12.4.2 (see separate volume of figures). Albert Embankment (A3036) forms part of a continuous north-south link for pedestrians The Albert Embankment (A3036) starts at Lambeth Bridge and the footway follows part of the south bank of the River Thames for 400m before ending at the Vauxhall Cross.

12.4.4 Signalised pedestrian crossing facilities are provided on Albert Embankment (A3036) approximately 250m northeast of the site at Albert Embankment Gardens and at the Albert Embankment (A3036) junction with Black Prince Road, a further 315m to the north,aiding east-west movements and reducing severance for pedestrians wishing to cross Albert Embankment (A3036).

12.4.5 Additional pedestrian crossings are located to the southwest of the site at Vauxhall Cross to provide access to Vauxhall Underground, rail and bus stations.

12.4.6 The Thames Path routes along the bank of the River Thames to the southwest of Vauxhall Bridge. The majority of the Thames Path which routes along the southeastern boundary of the Albert Embankment Foreshore site lies within the proposed site boundary. From Vauxhall Bridge the Thames Path routes eastwards between the riverside and the Vauxhall Cross. The path crosses Lacks Dock to the river frontage outside Camelford House, continuing to Albert Embankment Gardens and Albert Embankment (A3036). The Thames Path along the southern side of the river is greater than 2m wide and has viewing / rest points located approximately every 15-20m.

Cycle facilities and routes

12.4.7 The existing cycle network and facilities in the vicinity of the site are shown in Vol 16 Figure 12.4.2 (see separate volume of figures).

12.4.8 Cyclists are not permitted to use the section of the Thames Path which routes adjacent to the Albert Embankment Foreshore site. However there are a number of other cycle routes in the vicinity of the site.

12.4.9 The National Cycle Network Route 4 can be accessed on Vauxhall Bridge Road approximately 750m west of the site. This routes from Putney to Greenwich.

12.4.10 Route 37 of the London Cycle Network (LCN) routes from Vauxhall to Putney on the southern side of the River Thames along Nine Elms Lane and can be joined at the Vauxhall Gyratory approximately 250m south of the site access.

12.4.11 LCN Route 3 also routes close to the Albert Embankment Foreshore site and can be joined at Kennington Oval approximately 700m east of the site. This route links Waterloo to Earlsfield via Stockwell and Clapham Common.

12.4.12 The closest cycle parking provision to the Albert Embankment Foreshore site is located at Vauxhall rail station and can be accessed by Route 37 of the LCN. There are five cycle stands at the station which are located approximately 200m walking distance from the Albert Embankment Foreshore site access.

12.4.13 The closest Cycle Superhighways (CS) to the site are CS7 and CS8 which route from Merton to the City and Wandsworth to Westminster respectively.

12.4.14 The CS7 route starts on the High Street in Colliers Wood and routes along the A24 Tooting High Street via Balham High Road, Clapham High Street, Kennington Park Road, Southwark Bridge Road before finishing at Southwark Bridge with an approximate 45 minute journey from Merton to the City. The nearest point of approach for the CS7 route to the Albert Embankment Foreshore site is at the junction of Clapham Road and Camberwell New Road approximately 1.1km east of the site.

12.4.15 The CS8 route starts on Ram Street and continues through York Road, Battersea Park Road, Queenstown Road, Chelsea Bridge and Grosvenor Road before finishing at Millbank with an approximate 30 minute journey from Wandsworth to Westminster. The nearest point of approach for the CS8 route to the Albert Embankment Foreshore site is on the western side of Vauxhall Bridge approximately 550m from the site access.

12.4.16 There are cycle hire docking stations 300m walking distance north of the site along Albert Embankment (A3036) on the western footway and at the Vauxhall Cross to the southeast of the site. These cycle docking stations accommodate 21 and 17 bicycles respectively. A further docking station is located at the Kennington Lane rail bridge approximately 300m walking distance east of the Albert Embankment Foreshore site which can accommodate 36 bicycles.

Public Transport Accessibility Level

12.4.17 The Public Transport Accessibility Level (PTAL) of the site has been calculated using TfL's approved PTAL methodology (TfL, 2010)[5] and assumes a walking speed of 4.8km/h and considers rail stations within a 12 minute walk (960m) of the site and bus stops within an eight minute walk (640m).

12.4.18 Using this methodology the site has a PTAL rating of 6b, rated as 'excellent' (with 1a being the lowest accessibility and 6b being the highest accessibility).

12.4.19 Vol 16 Figure 12.4.3 (see separate volume of figures) shows the public transport network around the Albert Embankment Foreshore site.

Bus routes

12.4.20 As shown in Vol 16 Figure 12.4.3 (see separate volume of figures) a total of ten daytime and six night-time bus routes operate within a 640m walking distance of the site.

12.4.21 These bus routes operate from the following bus stops:

a. Vauxhall Gyratory bus stop on Albert Embankment (A3036) – northbound and southbound – 50m walking distance south and east of the site

b. Vauxhall Bus Station bus stop on Wandsworth Road (A3036) – northbound and southbound - 230m and 360m walking distance south of the site respectively

12.4.22 These routes would also serve other stops further from the site as shown on Vol 16 Figure 12.4.3.

12.4.23 On average there are 145 daytime bus services in the AM peak hour and 146 in the PM peak hour within 640m walking distance of the site. With regard to night-time bus services, there are approximately six bus services (some night buses and some 24 hour buses) per hour Monday to Friday between 00:00 and 06:00 and a total of nine bus services per hour on Saturdays between 00:00 and 06:00 within a 640m walking distance of the site.

London Underground

12.4.24 As shown on Vol 16 Figure 12.4.3 (see separate volume of figures) Vauxhall Underground Station located approximately 250m walking distance to the southeast of the site is the closest Underground station to the site and is served by the Victoria Line.

12.4.25 Victoria Line trains serving this station travel northbound to Green Park, King's Cross, Tottenham Hale and Walthamstow Central and southbound to Brixton.

12.4.26 Pimlico Underground station, which is also served by the Victoria Line, is located approximately 950m walking distance to the west of the Albert Embankment Foreshore site across the River Thames and is accessed via Vauxhall Bridge.

12.4.27 In the AM and PM peak hours the frequency of services on the Victoria Line is approximately every three minutes providing an average of 21 services per hour in each direction.

National Rail

12.4.28 The closest National Rail station to the site is Vauxhall rail station to the southeast of the site access approximately 200m walking distance from the site.

12.4.29 Vauxhall rail station provides access to Southwest train services and provides southbound services to Guildford, Woking, Clapham Junction, Chessington South, Hampton Court and Shepperton and northbound services to London Waterloo.

12.4.30 In the AM peak hour approximately 90 rail services (62 southbound and 28 northbound) call at Vauxhall station. In the PM peak hour there are approximately 82 services (61 southbound and 21 northbound).

River passenger services

12.4.31 The Millbank Millennium Pier is approximately 950m walking distance to the northwest of the site on the northern bank of the River Thames and St George Wharf Pier is approximately 200m walking distance to the southwest of the site on the southern bank of the river. The London Eye Pier is also 1.4km walking distance to the north of the Albert Embankment Foreshore site on the southern bank of the river.

12.4.32 The Millbank Millennium Pier and St George Wharf Pier accommodate services run by Thames Clippers between St George Wharf and Bankside, which operate seven days a week. In the AM peak hour St George Wharf Pier serves two ferries in both the eastbound and westbound direction while the Millbank Millennium Pier serves one ferry in the eastbound direction. In the weekday PM peak hour St George Wharf Pier serves two ferries in the eastbound and westbound direction while the Millbank Millennium Pier serves two ferries in the eastbound direction and one ferry in the westbound direction. On Saturdays both piers operate services every 40 minutes in each direction from approximately 09:30 to 20:00.

12.4.33 The London Eye Pier operates services only in an eastbound direction which terminate at Royal Arsenal Woolwich. This service is also run by Thames Clippers with three services in the AM and PM peak hours. Ferries run every 20 minutes on weekends during peak times.

12.4.34 The Albert Embankment Foreshore site is adjacent to Lacks Dock, a slipway which is used by London Duck Tours' small amphibious vessels that take passengers on 75 minute tours on the River Thames. Departure times for this service range from 10:00 to 12:00 and 14:00 to 16:00 daily between February and December and Wednesday to Sunday in January. Tours depart at regular intervals approximately every hour but exact departure times vary.

River navigation

12.4.35 An analysis has been made of the typical volume of river vessel traffic passing the Albert Embankment Foreshore site, based on published river passenger service timetables and estimates of freight traffic based on discussions with operators.

12.4.36 It is estimated that the peak hour for vessels passing the Albert Embankment Foreshore site is between 15:00 and 16:00 hours, Monday to Friday. During this hour approximately 11 vessels are estimated to pass the site. However this figure is not constant as freight vessel transit patterns are influenced by the rising and falling tide. Therefore, such a peak will only occur every ten to 12 days when the tide is at its highest[6].

Parking

12.4.37 Vol 16 Figure 12.4.4 (see separate volume of figures) shows the locations of the existing car parks and car club locations within the vicinity of the site.

Existing on-street car parking

12.4.38 There is no on-street parking located along Albert Embankment (A3036), which is subject to TLRN restrictions.

12.4.39 On-street parking is provided along Goding Street, approximately 200m walking distance east of the site. Parking at the southern end of Goding Street is for residents with permits to park in the 'KB' and 'KSB' Controlled Parking Zone (CPZ) which operates between 08:30 and 18:30, Monday to Friday. Parking on the northern end of Godling Street is subject to the same restrictions but also has pay and display parking for a maximum stay of four hours.

Existing off-street/private car parking

12.4.40 The nearest private car park is located at 37-38 Miles Street approximately 500m walking distance southeast of the site providing approximately 35 parking spaces. In addition, a Sainsbury's car park is located at 62 Wandsworth Road approximately 850m walking distance to the south of the site access which provides a further 450 parking spaces for customers only.

12.4.41 There is a Tesco car park located at Kennington Lane approximately 1.1km to the east of the site. This car park is free to customers of Tesco, however has a maximum stay of two hours.

Coach parking

12.4.42 Coach parking is provided on the western side of Albert Embankment (A3036) to the north of the Albert Embankment (A3036) / Tinworth Street junction, 250m walking distance north of the site. These bays can accommodate up to seven coaches.

Car clubs

12.4.43 The closest car club parking space to the site is operated by ZipCar and is approximately 340m walking distance southwest of the site on St George Wharf where three vehicle spaces are provided.

12.4.44 There are also car club spaces at several locations to the southeast and east of the site. The closest of these locations are on Parry Street (south of the site) and Kennington Lane (southeast of the site) which are both approximately 550m walking distance from the site access on Albert Embankment (A3036).

Servicing and deliveries

12.4.45 There are no on-street loading bays in the immediate vicinity of the Albert Embankment Foreshore site.

Taxis

12.4.46 The nearest taxi rank to the site is located on Albert Embankment (A3036) 450m walking distance east of the site at the Riverbank Park Plaza Hotel where two taxi spaces are located.

Highway network and operation

12.4.47 The site is located to the west of Albert Embankment (A3036) and to the north of Vauxhall Bridge Road (A202), both of which form part of the TLRN. Albert Embankment (A3036) routes from Lambeth Road Roundabout in the north to Vauxhall Gyratory in the south.

12.4.48 Albert Embankment (A3036) is a four lane carriageway (northbound and southbound) with a 30mph speed limit. A bus lane is present on both sides of the road with bus stops located to the south of the site in close proximity to the junction of Albert Embankment (A3036) with New Springs Garden Walk.

12.4.49 To the south, Albert Embankment (A3036) forms one arm of the signalised seven-arm Vauxhall Gyratory, with three lanes on entry to and exit from the junction.

12.4.50 To the north, Albert Embankment (A3036) forms a junction with Lambeth Palace Road (A3036), Lambeth Road (A3203) and Lambeth Bridge Road (A3203). This is a four-arm roundabout with signalised pedestrian facilities on each arm including pedestrian refuges on all arms.

12.4.51 Vauxhall Bridge Road (A202) routes from Vauxhall Gyratory towards Victoria in the northwest. The stretch of road across Vauxhall Bridge is a single four lane carriageway in both directions, with a bus lane present on both sides of the road.

Data from third party sources

Description of data

12.4.52 Data in relation to traffic flows and accident records for the most recent five-year period have been sourced from TfL.

Accident analysis

12.4.53 During the five year period, a total of 111 accidents occurred within the assessment area analysed. Of these accidents, 92 were categorised as slight and 17 were serious and two fatal.

12.4.54 The two fatal accidents occurred on Albert Embankment (A3036). The first accident occurred north of the Albert Embankment (A3036) / Vauxhall Bridge Road (A202) junction and involved a vehicle leaving the carriageway and hitting a pedestrian. The record of the accident does not suggest a reason for the vehicle leaving the carriageway. The other fatal accident also occurred at the Albert Embankment (A3036) / Vauxhall Bridge Road (A202) junction and involved a pedestrian being hit by a car when using the pedestrian crossing. In this instance the driver of the vehicle was under the influence of drugs.

12.4.55 In general, the accidents largely involved cars, motorcyclists, pedestrians and pedal cyclists. Five of the accidents involved HGVs and one MGV. 13 of the total accidents involved pedestrians and 34 involved pedal cycles.

12.4.56 The details available within the accident records suggest that the accidents that occurred within the vicinity of the site were caused by vehicle and pedestrian path conflicts resulting from drivers or pedestrians not looking properly or careless driving. There is no indication that the accidents were due to highway geometry or poor infrastructure.

Traffic flow data

12.4.57 Traffic count data have been collected from TfL for Albert Embankment (A3036) to identify the traffic flows along this road in 2011. The greatest flow along this link was found to be on a weekday with the busiest hour being the PM peak hour with an average two-way flow of approximately 930 vehicles.

Survey data

Description of surveys

12.4.58 Baseline survey data were collected in May, July and August / September 2011 to establish the existing transport movements in the area. Vol 16 Figure 12.4.5 (see separate volume of figures) shows the survey locations in the vicinity of the site.

12.4.59 As part of the surveys undertaken in May, July and September 2011 manual traffic surveys were undertaken to establish specific traffic, pedestrian and cycle movements including turning volumes, queue lengths, saturation flows, degree of saturation and traffic signal timings. Surveys were conducted in August 2011 to establish the summer usage of the Thames Path.

Results of the surveys

Pedestrians and cyclists

12.4.60 Pedestrian surveys were undertaken on the Thames Path to the west of Camelford House during the AM and PM peak hours. In the AM peak hour, approximately 170 pedestrians use the Thames Path compared to 143 pedestrians in the PM peak hour.

12.4.61 On the western footway along Albert Embankment (A3036), a pedestrian flow of 342 pedestrians passed along this footway in the AM peak hour and 231 in the PM peak hour. On the eastern side of Albert Embankment (A3036), 547 pedestrians used the footway in the AM peak hour, while 535 pedestrians used the footway in the PM peak hour.

12.4.62 Cycle surveys were also undertaken on the Thames Path to the west of Camelford House. In the AM peak hour, approximately 25 cyclists use the Thames Path compared to 22 cyclists in the PM peak hour.

12.4.63 On Albert Embankment (A3036), a cyclist flow of four passed along the western footway in the AM peak hour and five in the PM peak hour. On the eastern side of Albert Embankment (A3036) approximately four cyclists used the footway in the AM peak hour, while only one used the footway in the PM peak hour.

Traffic flows

12.4.64 The traffic count data have been analysed to identify the existing traffic flows by direction along Albert Embankment (A3036). In the weekday AM peak hour northbound flows were dominant with approximately 200 vehicles every 15 minutes. Southbound flows were around 125 vehicles every 15 minutes. The peak two-way flow of 1,300 vehicles occurred in the AM peak hour. During the PM peak hour directional flows were more balanced and ranged between 130 and 170 vehicles per direction every 15 minutes. The total two way flow in the PM peak hour was approximately 600 vehicles.

12.4.65 The traffic flows for the busiest periods (weekday AM and PM peak hours) within the area are shown in Vol 16 Figure 12.4.6 and Vol 16 Figure 12.4.7 (see separate volume of figures).

Local highway modelling

12.4.66 To establish the existing capacity on the local highway network a scope was agreed with TfL and the LB of Lambeth to model the effects of the Albert Embankment Foreshore site using a PICADY model for the junction between Albert Embankment (A3036) and the Lacks Dock access. The baseline model incorporates the current traffic and transport conditions within the vicinity of the site and followed the methodology outlined in Vol 2.

12.4.67 The weekday AM and PM baseline model flows were compared against observed queue lengths for the peak periods (from junction surveys) to validate the PICADY model and ensure reasonable representation of existing conditions.

12.4.68 Vol 16 Table 12.4.1 shows the modelling outputs which demonstrate that this junction is currently operating with spare capacity in the weekday AM and PM peak hours. The validated model indicates the highest value of RFC is 1% occurring in the AM peak hour and the maximum mean delay is 12 seconds per vehicle. There is no queuing at this junction.

12.4.69 The alternative access junction with Albert Embankment (A3036) (Option B) between Camelford House and Tintagel House was also modelled, but as this is a new access there is no baseline model, only a construction development model.

Vol 16 Table 12.4.1 Transport – baseline PICADY model outputs

Approach	Movement	Weekday							
		AM peak hour (08:00-09:00)				PM peak hour (17:00-18:00)			
		Flow (veh/hr)	RFC (%)	MMQ	Delay (seconds)	Flow	RFC (%)	MMQ	Delay (seconds)
Lacks Dock slipway	Left/right onto Albert Embankment (A3036)	0	0	0	0	2	0	0	9
Albert Embankment (A3036) (southbound)	Right onto Lacks Dock slipway	2	1%	0	12	0	0	0	0

Notes: 1. RFC represents Ratio of Flow to Capacity. MMQ represents Mean Maximum Queue for the busiest-case 15 minute modelled period (in vehicle lengths). Delay represents the mean delay per vehicle.
2. Albert Embankment (A3036) northbound is not included in table as PICADY model only considers movements where vehicles have to give way.

Transport receptors and sensitivity

12.4.70 Vol 16 Table 12.4.2 summarises the receptors in the vicinity of the Albert Embankment Foreshore site and their sensitivities. The transport receptor sensitivity is defined as high, medium or low using the criteria detailed in Vol 2.

12.4.71 The transport effects identified in this assessment are directly related to changes to the operation of transport networks which may occur as a result of physical changes to transport networks or of additional vessel or vehicle movements or additional public transport patronage. These changes in operation could lead to effects which would be experienced by people using those transport networks, whether as pedestrians, cyclists, public transport or private vehicle users. The assessment identifies several 'generic' groups of transport users in the list of transport receptors.

12.4.72 Receptors who are occupiers and users of or visitors to existing or committed developments in the vicinity of each of the project sites may experience transport effects on their journeys to and from those developments. In many cases those effects would be similar (or identical) to the effects identified for the 'generic' groups of transport users. However, the assessment specifically includes these receptors to ensure that any particular effects that they would be likely to experience (for instance because they make use of particular routes or transport facilities) have been identified.

Vol 16 Table 12.4.2 Transport – receptors and sensitivity

Receptors (relating to all identified transport effects)	Phase at which receptor is sensitive to identified effects	Value/sensitivity and justification
Pedestrians (including sensitive pedestrians[iv]) using the Thames Path and Albert Embankment (A3036) footways.	Construction Operation	High sensitivity to diversions, resulting in increases to journey times and loss of amenity.
Cyclists routing northbound along Albert Embankment (A3036).	Construction Operation	High sensitivity to increases in journey time due to an increase in HGV traffic and potential infrequent traffic management at the site access.
Private vehicles in the area using the local highways or	Construction Operation	Medium sensitivity to increases in journey time due to an increase in HGV

[iv] Sensitive pedestrians include those with mobility impairments, including wheelchair users.

Receptors (relating to all identified transport effects)	Phase at which receptor is sensitive to identified effects	Value/sensitivity and justification
on-street parking		traffic and occasional traffic management at the site access.
Emergency vehicles travelling on Albert Embankment (A3036).	Construction Operation	High sensitivity to journey time delays due to time constraints on journey purposes.
Bus users (passengers) travelling northbound along Albert Embankment (A3036).	Construction Operation	Medium sensitivity to journey time delays as a result of increases to traffic flows and occasional traffic management measures at the site access.
River vessel operators including river passenger services.	Construction	Low sensitivity to increases in river vessel movements resulting in journey time delay for existing river vessel operators.
Public transport users using rail or river services within the area.	Construction	Low sensitivity due to distance from the site and low numbers of construction workers.
Residents of St George's Wharf, adjacent to southeast of the site.	Construction	High sensitivity to increases in river and HGV traffic and changes to pedestrian environment resulting in journey time delays.
Occupants of Vauxhall Cross, directly to the east of the site.	Construction	Medium sensitivity to increases in HGV traffic and changes to the pedestrian environment resulting in journey time delay for staff and visitors.
Occupants Camelford House, directly to the east of the site.	Construction	Medium sensitivity to increases in HGV traffic and changes to the

Receptors (relating to all identified transport effects)	Phase at which receptor is sensitive to identified effects	Value/sensitivity and justification
		pedestrian environment resulting in journey time delay for staff and visitors.
Occupants of Tintagel House, directly to the northeast of the site.	Construction	Medium sensitivity to increases in HGV traffic and changes to the pedestrian environment resulting in journey time delay for staff and visitors.
Users of recreational spaces at Albert Embankment Gardens, 85m northeast of the site, and the Thames Path adjacent to site boundary.	Construction	Medium sensitivity to changes to footways and highway operations.
Users of Lacks Dock access road including Duck Tours	Construction Operation	Medium sensitivity to increases in HGV traffic using the Lacks Dock junction with Albert Embankment (A3036) and occasional traffic management at the access resulting in journey time delay.

Construction base case

12.4.73 As described in Section 12.3 the construction assessment year for transport is Site Year 1 of construction.

12.4.74 There are no known proposals to change the cycle or pedestrian network by Site Year 1 of construction and therefore the network would operate as indicated in the baseline situation.

12.4.75 In terms of the public transport network no change is expected on London Underground Victoria line services as capacity upgrades have recently been completed and there are no specific proposals to enhance National Rail capacity. It is envisaged that London Underground and National Rail patronage will increase by Site Year 1 of construction.

12.4.76 In order to ensure that the busiest base case scenario is used in the assessment the capacity for National Rail and London Underground in the base case has been assumed to remain the same as capacity in the baseline situation. This ensures a robust assessment as outlined in Vol 2.

12.4.77 There are no known proposals to alter river passenger services or river navigation patterns from the current baseline conditions and therefore the construction base case remains similar to the baseline position.

12.4.78 As described in para. 12.3.9, the traffic flows for the base case have been calculated by considering the net change in traffic from the identified committed developments in the area (see paras. 12.3.6-12.3.7) and adding this to baseline traffic survey flows. This approach ensures that the construction base case for the highway network is robust. The construction base case traffic flows are shown on Vol 16 Figure 12.4.6 and Figure 12.4.7 (see separate volume of figures).

12.4.79 The key findings from the construction base case PICADY model for the site access and Albert Embankment (A3036) indicate that there would not be an increase in queuing in the construction base case compared to baseline conditions.

12.4.80 Results indicate that the junction would continue to operate within capacity when taking into account the construction base case traffic flows.

12.4.81 The construction base case takes into account traffic growth and new developments within the local area by Site Year 1 of construction, including the developments detailed in paras. 12.3.6 and 12.3.7. Developments within 250m of the site are considered to present potential receptors to transport effects, as described in Vol 2. Additional receptors have been identified on this basis and these are detailed in Vol 16 Table 12.4.3.

Vol 16 Table 12.4.3 Transport - construction base case additional receptors

Receptors (relating to developments within 1km of the site)	Phase at which receptor is sensitive to identified impacts	Value/sensitivity and justification
Occupants of development at 2-14 Tinworth Street and 108-110 Vauxhall Walk, 120m northeast of site Occupants of Eastbury House, 150m northeast of site Occupants of Riverwalk House, 160m northwest of site Occupants of 1-9 Bondway / 4-6 South Lambeth Place, 185m southeast of site	Construction	Medium sensitivity to increases in HGV traffic and changes to pedestrian and cycle environment resulting in journey time changes for residents and other occupiers.

Receptors (relating to developments within 1km of the site)	Phase at which receptor is sensitive to identified impacts	Value/sensitivity and justification
Occupants of the St George's Wharf (Vauxhall Tower) development, 200m south of site Occupants of the Hampton House development, 230m northeast of site		

Operational base case

12.4.82 The operational assessment year for transport is Year 1 of operation.

12.4.83 As explained in para. 12.2.22 the elements of the transport network considered in the operational assessment are highway layout and operation and pedestrian routes in the vicinity of the Albert Embankment Foreshore site. For the purposes of the operational base case it is anticipated that the highway layout and parking and the route of the Thames Path will be as indicated in the construction base case.

12.4.84 The operational base case in Year 1 of operation takes into account the developments described in Vol 16 Appendix N (site development schedule) described in para. 12.3.19. Given that the effects in the operational phase would be limited to effects on pedestrians and on highway operation in the immediate vicinity of the Albert Embankment Foreshore site it is not necessary to consider additional receptors beyond those identified for the construction base case.

12.5 Construction effects assessment

12.5.1 This section summarises the findings of the assessment undertaken for the peak year of construction at the Albert Embankment Foreshore site (Site Year 1 of construction).

12.5.2 The anticipated mode split of worker trips (covering all types of construction worker described in Vol 16 Table 12.2.2) for the Albert Embankment Foreshore site is detailed in Vol 16 Table 12.5.1and has been generated based on 2001 Census data for journeys to workplaces in the vicinity of the Albert Embankment Foreshore site[v]. This shows that the predominant mode of travel for journeys to work in this area is public transport.

12.5.3 At this site there would be no parking provided within the site boundary for workers. As parking on surrounding streets is also restricted, and

[v] Based on 2001 Census as this type of data had not been released from the 2011 Census at the time of assessment.

measures to reduce car use would be incorporated into site-specific *Travel Plan* requirements, it is highly unlikely that workers would travel by car. The Census mode shares have therefore been adjusted in Vol 16 Table 12.5.1 to reflect increased levels of non-car use by workers at this site. This forms the basis of the assessment.

Vol 16 Table 12.5.1 Transport – mode split

Mode	Percentage of trips to site	Equivalent number of worker trips (based on 65 worker trips)	
		AM peak hour	PM peak hour
Bus	13%	9	9
National Rail	42%	27	27
Underground	30%	20	20
Car driver	<1%*	0	0
Car passenger	<1%*	0	0
Cycle	4%	2	2
Walk	7%	5	5
River	0%	0	0
Other (taxi/motorcycle)	3%	3	3
Total	**100%**	**65**	**65**

**Assumed to be zero for the purposes of the assessment*

Pedestrian routes

12.5.4 The Thames Path routes along the riverside footway of Albert Embankment (A3036) between the river and Camelford House and would require diversion as a result of the construction works for both access options. This would be necessary throughout the construction period.

12.5.5 Pedestrians would be directed along the western side of Albert Embankment (A3036) between Albert Embankment Gardens and the Vauxhall Bridge (A202) / Wandsworth Road (A3036) junction. To the south, pedestrians would be able to cross at the signalised pedestrian crossing on Vauxhall Bridge Road (A202) to connect with the existing Thames Path route on the western side of Wandsworth Road (A3036).

12.5.6 The construction phase layout – phases 1-4 plans (see separate volume of figures – Section 1) show the pedestrian footway layout during construction for options A and B.

12.5.7 To assess a busiest case scenario it has been anticipated that all worker trips would finish their journeys by foot. As a result the 65 worker trips generated by the site have been added to the construction base case pedestrian flows during the AM and PM peak hours. The diversion of pedestrians from the Thames Path would add between 235 and 208 pedestrian movements to this footway in the AM and PM peak hours respectively. As stated in Vol 16 Table 12.3.1, LB Lambeth has agreed that the footway on Albert Embankment (A3036) has adequate capacity to accommodate the diversion.

12.5.8 In determining the magnitude of impacts on pedestrian routes the relevant impact criteria are: pedestrian delay, pedestrian amenity and accidents and safety (as set out in Vol 2).

12.5.9 It is anticipated that the pedestrian diversions around the Albert Embankment Foreshore site would result in a slight increase in journey time of no more than 15 seconds based on a walk speed of 4.8km per hour. The route of the Thames Path diversion along the western side of Albert Embankment (A3036) is shorter than the existing route by approximately 48m and this equates to a journey time reduction of approximately 40 seconds. However pedestrians would need to use the signalised pedestrian crossing at the Vauxhall Bridge Road (A202) / Wandsworth Road (A3036) junction which would add an average delay of 40 seconds to their journey. Additionally they would have to cross the site access which could add a maximum of 15 seconds to the journey time.

12.5.10 If the alternative access between Camelford House and Tintagel House were to be used instead of a new access along Lacks Dock, as the access for plant/machinery would still be along Lacks Dock the total delay could be 30 seconds as pedestrians could be delayed at both accesses.

12.5.11 In either case, overall this would result in a negligible impact on pedestrian delay, for those walking along the western side of Albert Embankment (A3036). Other pedestrian movements in the area would also experience a negligible impact.

12.5.12 With regards to pedestrian amenity the diversion of the Thames Path would result in pedestrians having to use a signalised road crossing as opposed to a pedestrian underpass when they reach Vauxhall Bridge Road (A202). This equates to a high adverse impact on pedestrian amenity.

12.5.13 In relation to accidents and safety, in addition to the need to cross Vauxhall Bridge Road (A202) pedestrians would also be required to cross the site access(es) on Albert Embankment (A3036), which is directly onto the TLRN. The impact magnitude for pedestrian accidents and safety would therefore be classified as high adverse using the criteria set out in Vol 2.

Cycle facilities and routes

12.5.14 The relevant impact criteria for determining the magnitude of impacts on cycle facilities and routes are cycle delay and accidents and safety (as set out in Vol 2).

12.5.15 Cyclists are not permitted to use the Thames Path in the vicinity of Albert Embankment (A3036) and therefore the Thames Path diversion would not result in a delay for cyclists. Additionally, cyclists using the highway would not experience delay to journey time as a result of the construction works at the Albert Embankment Foreshore site. The impact on cycle delay would therefore be negligible.

12.5.16 With regard to accidents and safety, while cyclists would not be required to make any additional road crossings along Albert Embankment (A3036), there would be an increase in construction traffic flow of between four and 20 two-way HGV movements per hour. This represents a low adverse impact.

Bus routes and patronage

12.5.17 The 77, 344 and 360 bus services route immediately past the site. Construction vehicles serving the site and occasional traffic management measures at the site access if a construction vehicle were to be refused entry (see para. 12.2.18, bullet g.) may therefore affect these bus routes in terms of their journey times.

12.5.18 The effect on journey times is detailed under the highway operation and network assessment (paras. 12.5.51-12.5.52) which concludes that the effect would be negligible.

12.5.19 It is expected that approximately nine additional two-way worker trips would be made by bus during the AM and PM peak hours, which would result in less than one worker trip per bus (based on a service of 145 buses within a 640m walking distance during the AM and PM peak hours).

12.5.20 Based on the impact criteria outlined in Vol 2 the additional worker trips made by bus in peak hours would therefore have a negligible impact on bus patronage.

London Underground and National Rail services and patronage

12.5.21 No Underground or National Rail stations are directly adjacent to the site and therefore none would be directly affected by the construction works at the Albert Embankment Foreshore site.

12.5.22 It is anticipated that approximately 47 construction workers and labourers would use London Underground or National Rail services to access the site which would result in 27 additional person trips on National Rail services and 20 additional person trips on London Underground services in each of the AM and PM peak hours.

12.5.23 On London Underground services this equates to less than one person per train during the AM and PM peak hours based on an average frequency of 42 trains during each of the peak hours. On National Rail services there would also be less than one additional passenger per train based on the AM peak hour service of 90 arrivals and PM peak hour service of 82 departures.

12.5.24 Based on the quantitative assessment of patronage and the impact criteria on rail patronage in Vol 2 this would result in a negligible impact on London Underground and National Rail patronage.

River passenger services and patronage

12.5.25 No river passenger services would be directly affected during construction. It is anticipated that less than 1% of construction workers and labourers would use the river services to access the construction site, which would result in a maximum of one construction work per boat service.

12.5.26 In accordance with the impact criteria for river patronage set out in Vol 2, this would result in a negligible impact on river passenger service patronage.

River navigation

12.5.27 This section addresses the effects on river navigation and access in the vicinity of the Chelsea Embankment Foreshore site. The wider effects of transporting construction materials by river from a number of sites within the project are dealt with in Vol 3.

12.5.28 During construction it is intended that the cofferdam fill (import and export), shaft excavated and 'other' material (export) would be transported by barge. For assessment it is taken as 90% of these materials are by river to take into account periods where river transport is unavailable or the material is unsuitable. The peak number of barge movements would occur in Site Year 1 of construction with a daily average of eight barge movements a day.

12.5.29 Due to the low number of barges arriving at the site and based on the impact criteria outlined in Volume 2 it is anticipated that the impact on river navigation in the vicinity of the site as a result of the barges arriving at Albert Embankment Foreshore would be negligible.

12.5.30 A separate *Navigational Issues and Preliminary Risk Assessment* has been undertaken for the temporary construction works and barges to be used at the Albert Embankment Foreshore site. This is reported separately outside of the *Environmental Statement* and *Transport Assessment* that both accompany the application.

Parking

12.5.31 No on-street parking is permitted on Albert Embankment (A3036) in the vicinity of the site due to TLRN restrictions. As it is not expected that construction workers would drive to the site, there would be no impact on on-street parking or private parking in the vicinity of the area during the construction phase.

12.5.32 With regard to determining the magnitude of impacts the relevant criteria with respect to the assessment of parking is vehicle parking and loading changes (as set out in Vol 2).

12.5.33 For access Option A; while the relocation of the security hut would require the removal of two parking bays in the Camelford House car park, it is expected that sufficient capacity is available in the remainder of the car park to accommodate this loss of capacity. The impact for Camelford House car park users would therefore be negligible. There are no loading bays in the vicinity, therefore there is no impact on loading at this site.

12.5.34 In the case of Option B, the new access between Camelford House and Tintagel House would require the removal of six parking bays in the Tintagel House car park and two parking bays in the Camelford House car park. These parking bays would not be reprovided. Although Tintagel House is currently unoccupied and therefore the parking spaces associated with this building are not in use, it is likely to be occupied by Site Year 1 of construction and hence the parking spaces may be in use. The new access road in Option B would also require the reduction from two lanes to one lane on the ramp to the Camelford House underground car park. A traffic light system would operate at the top and bottom of the ramp to prevent vehicle conflicts.

12.5.35 For Option B, although there would be no changes to on-street parking, the private car parks of Camelford House and Tintagel House would both experience a reduction in parking availability during construction. As Tintagel House is likely to be occupied by Site Year 1 the parking associated with may be required and would not be reprovided so its removal could have a high impact. Although the two Camelford House parking spaces that would be removed would not be replaced, it is again expected that sufficient capacity is available in the remainder of the car park to accommodate this loss of capacity and would therefore have a negligible impact on Camelford House parking.

Highway network and operation

12.5.36 The highway layout during construction plan (see separate volume of figures – Section 1) shows that the site would be accessed from the northbound lane of the Albert Embankment (A3036). There would be a gated access for the left-turn in, left turn out movement for construction traffic.

12.5.37 As described in para. 12.2.3, two access options are being considered for this site. In Option A the construction vehicle site access on Albert Embankment (A3036) would be at Lacks Dock which would be shared with the Duck Tours vehicles. The arrival of construction vehicles at the site would be managed to minimise conflict with Duck Tours vehicles as detailed in the *CoCP Part B* (Section 5).

12.5.38 In the event of a departing construction vehicle meeting an arriving Duck Tours vehicle, the Duck Tours vehicle would take priority in order to minimise delays to general traffic on Albert Embankment (A3036).

12.5.39 In the alternative Option B, the majority of construction vehicles would access the site via a new road constructed between Camelford House and Tintagel House forming a new junction with Albert Embankment (A3036) at this location. In this access option the access along Lacks Dock would also be required and would be used occasionally by vehicles transporting large construction plant/machinery. The same traffic management and priority operation for Duck Tours vehicles would be implemented for this alternative option as described for Option A.

12.5.40 The highway layout during construction vehicle swept path analysis plans (see Albert Embankment Foreshore Transport Assessment Figures) demonstrate that the construction vehicles would be able to safely enter and leave the site in both access options.

12.5.41 Construction lorry movements would be limited to the day shift only (08:00 to 18:00 Monday to Friday, 08:00 to 13:00 Saturday). In exceptional circumstances HGV and abnormal load movements could occur up to 22:00 on weekdays for large concrete pours and later at night by agreement with the LB of Lambeth. The assessment has been based on 10% of the daily number of lorry journeys occurring in the peak hours, which has been agreed with TfL as a reasonable approach. It is recognised that it may be desirable to reduce the number of construction lorry movements in peak hours and the mechanisms for addressing this would form part of the *Traffic Management Plans* which are required as part of the *CoCP* Part A (Section 5).

12.5.42 Vol 16 Table 12.5.2 shows the construction lorry movement assumptions for the local peak traffic periods. These are based on the peak months of construction activity at this site. The assessment has been based on 10% of the daily number of lorry journeys occurring in the peak hours, which has been agreed with TfL as a reasonable approach. It is recognised that it may be desirable to reduce the number of construction lorry movements in peak hours and the mechanisms for addressing this would form part of the *Traffic Management Plans* which are required as part of the *CoCP* Part A (Section 5).

Vol 16 Table 12.5.2 Transport – peak construction works vehicle movements

Vehicle type	Vehicle movements per time period				
	Total daily	07:00 to 08:00	08:00 to 09:00	17:00 to 18:00	18:00 to 19:00
Construction lorry vehicle movements 10%*	46	0	5	5	0
Other construction vehicle movements**	36	4	4	4	4
Worker vehicle movements***	nominal	0	0	0	0
Total	**82**	**4**	**9**	**9**	**4**

** The assessment has been based on 10% of the daily construction lorry movements associated with materials taking place in each of the peak hours.*
*** Other construction vehicle movements includes cars and light goods vehicles associated with site operations and contractor activity.*
**** Worker vehicle numbers based on less than 1% of workers driving, on the basis that there would be no worker parking on site; on-street parking in the area is restricted; and site-specific Travel Plan measures would discourage workers from driving. In practical terms, this would be close to zero.*

12.5.43 An average peak flow of 82 vehicle movements a day is expected during the months of greatest activity during Site Year 1 of construction at the

Albert Embankment Foreshore site. At other times in the construction period vehicle flows would be lower than this average peak figure.

12.5.44 The relevant criteria for determining the magnitude of impacts on the highway network and operation are; accidents and safety, road network delay and hazardous loads (as set out in Vol 2).

12.5.45 Construction vehicle arrivals at the site would be managed and if construction vehicles are refused entry and are required to reverse onto Albert Embankment (A3036) under supervision a minor delay to northbound traffic on Albert Embankment (A3036) would occur. It is expected that if this requirement does occur it would happen on an infrequent basis. The presence of a traffic marshal to guide vehicles out of the site access if they have been refused entry would reduce the risk of accidents.

12.5.46 It is anticipated that along Albert Embankment (A3036) there would be an additional five two-way HGV movements during the peak hour as a result of the construction at the Albert Embankment Foreshore site, plus an average of one two-way HGV movement during the peak hour associated with other Thames Tideway Tunnel project sites passing along Albert Embankment (A3036) during Site Year 1 of construction at the Albert Embankment Foreshore site. This together with the location of the site access directly onto the TLRN results in a medium adverse impact on accidents and safety.

12.5.47 It is assessed that potentially there would be one vehicle carrying hazardous loads to the site every fortnight. This represents a low adverse impact associated with the movement of hazardous loads from the Albert Embankment Foreshore site.

12.5.48 An additional security check would be required for construction vehicles entering this site due to the close proximity of the SIS building. This would require that each vehicle would be inspected at a remote vehicle holding area located no more than ten minutes from the site. The holding and inspection location has not yet been defined but is expected to be within the Nine Elms area. Vehicles would be inspected and given clearance to proceed to the site and on arrival at the site access would need to provide evidence of their security clearance.

12.5.49 The vehicle holding area would reduce the length of time that construction vehicles would need to be held at the site gate and could be used to control the arrival times of vehicles to the construction site.

12.5.50 The local PICADY model has been used to apply the construction demands and local geometrical changes to the construction base case to determine the changes in the highway network operation due to the project (ie, comparison of base and development cases). The development case traffic flows (providing input to the LinSig and PICADY models) are shown on Vol 16 Figure 12.4.6 and Figure 12.4.7 (see separate volume of figures).

12.5.51 A summary of the construction assessment results for Option A in the weekday AM and PM peak hours is presented in Vol 16 Table 12.5.3 and Vol 16 Table 12.5.4. The results indicate that there would be a negligible impact on capacity at the Lacks Dock slipway / Albert Embankment (A3036) junction.

12.5.52 The assessment shows that the road network delay during the AM and PM peak hours would be a maximum of 16 seconds per vehicle in the AM peak hour on Albert Embankment (A3036) southbound. However, this delay is predicted in both the base and development cases as it is not caused by Thames Tideway Tunnel project vehicles but by vehicles turning right out of Lacks Dock. The impact of the Thames Tideway Tunnel project construction traffic is therefore negligible.

Vol 16 Table 12.5.3 Transport – construction PICADY model outputs, AM peak hour (Option A)

Approach	Arm	Flow (veh/hr)	Weekday								
			AM peak hour (08:00-09:00)								
			RFC (%)			MMQ (vehicles)			Delay (seconds)		
			Base case	Devt case	Change	Base case	Devt case	Change	Base case	Devt case	Change
Lacks Dock slipway	Left/right onto Albert Embankment (A3036)	4	0	2%	+2%	0	0	0	0	21	+21
Albert Embankment (A3036) (southbound)	Right onto Lacks Dock slipway	2	1%	1%	0	0	0	0	16	16	0

Notes: 1. RFC represents Ratio of Flow to Capacity. MMQ represents Mean Maximum Queue for the busiest-case 15 minute modelled period (in vehicle lengths). Delay represents the mean delay per vehicle.
2. Albert Embankment (A3036) northbound is not included in table as PICADY model only considers movements where vehicles have to give way.

Vol 16 Table 12.5.4 Transport – construction PICADY model outputs, PM peak hour (Option A)

Approach	Arm	Flow	Weekday								
			PM peak hour (17:00-18:00)								
			RFC (%)			MMQ (vehicles)			Delay (seconds)		
			Base case	Devt case	Change	Base case	Devt case	Change	Base case	Devt case	Change
Lacks Dock slipway	Left/right onto Albert Embankment (A3036)	6	1%	2%	+1%	0	0	0	12	11	-1
Albert Embankment (A3036) (southbound)	Right onto Lacks Dock slipway	0	0	0	0	0	0	0	0	0	0

Notes: 1. RFC represents Ratio of Flow to Capacity. MMQ represents Mean Maximum Queue for the busiest-case 15 minute modelled period (in vehicle lengths). Delay represents the mean delay per vehicle.
2. Albert Embankment (A3036) northbound is not included in table as PICADY model only considers movements where vehicles have to give way.

12.5.53 If Option B were to be adopted, the geometry of the site access junction would be very similar to that for Option A. The traffic flows through the junction would also be very similar with the exception that total flows would be lower in Option B as the Option A modelling includes Duck Tours and Camelford House traffic. The outcomes of the Option A modelling therefore provide a reasonable representation of what could be expected from the Option B solution. The impact of the Thames Tideway Tunnel project construction traffic at this new junction in Option B is therefore expected to be negligible.

Significance of effects

12.5.54 The significance of the effects has been determined based on the transport impacts described above considered in the context of the sensitivity of the receptors identified in Vol 16 Table 12.4.2 and Vol 16 Table 12.4.3.

12.5.55 Vol 16 Table 12.5.5 sets out the effects on each receptor in the vicinity of the site.

Vol 16 Table 12.5.5 Transport – significance of effects during construction

Receptors (relating to all identified transport effects)	Significance of effect	Justification (receptor sensitivity and impacts)
Pedestrians (including sensitive pedestrians) using the Thames Path and Albert Embankment (A3036) footways	Moderate adverse effect	• High sensitivity • Negligible impact on pedestrian delay • High adverse impact on pedestrian amenity and accidents and safety • Due to impacts ranging from negligible to high adverse this equates to moderate adverse effect.
Cyclists routing northbound along Albert Embankment (A3036)	Minor adverse effect	• High sensitivity • Negligible impact on cycle delay. • Low adverse impact on accidents and safety. • Due to the mix of minor adverse and negligible impacts, equates to a minor adverse effect
Private vehicles in the area using the local highways or on-street parking.	Minor adverse effect on highway users Negligible effect on parking users	**Highway users:** • Medium sensitivity. • Negligible impact on road network delay. • Medium adverse impact on accidents and safety.

Receptors (relating to all identified transport effects)	Significance of effect	Justification (receptor sensitivity and impacts)
		• Low adverse impact from hazardous loads. • Due to negligible, low adverse and medium adverse impact magnitudes and the sensitivity of the receptor this equates to a minor adverse effect. **Parking users:** • Medium sensitivity. • No impact on on-street parking. • Due to no impact, this equates to negligible effect.
Emergency vehicles travelling on Albert Embankment (A3036).	Minor adverse effect	• High sensitivity • Negligible impact on road network delay. • Medium adverse impact on accidents and safety. • Low adverse impact from hazardous loads. • Due to negligible, low adverse and medium adverse impact magnitudes and the sensitivity of the receptor this equates to a minor adverse effect.
Bus users (passengers) travelling northbound along Albert Embankment (A3036).	Negligible effect	• Medium sensitivity • Negligible impact on road network delay and patronage. • Due to negligible impacts this equates to a negligible effect.
River vessel operators including river passenger services.	Negligible effect	• Low sensitivity • Negligible impact on river navigation • Due to negligible impact, equates to negligible effect
Public transport users using rail or river services within the area	Negligible effect	• Low sensitivity • Negligible impact on patronage • Due to negligible impact, equates to negligible effect.

Receptors (relating to all identified transport effects)	Significance of effect	Justification (receptor sensitivity and impacts)
Residents of Bridge House	Moderate adverse effect on pedestrians. Minor adverse effect on cyclists. Minor adverse effect on highway users Negligible effect on parking users	**Pedestrians:** • High sensitivity • Negligible impact on pedestrian delay • High adverse impact on pedestrian amenity and accidents and safety • Due to impacts ranging from negligible to high adverse this equates to moderate adverse effect. **Cyclists:** • High sensitivity • Negligible impact on cycle delay. • Low adverse impact on accidents and safety. • Due to the mix of minor adverse and negligible impacts, equates to a minor adverse effect **Highway users:** • Medium sensitivity • Negligible impact on road network delay. • Medium adverse impact on accidents and safety. • Low adverse impact from hazardous loads. • Due to negligible, low adverse and medium adverse impact magnitudes and the sensitivity of the receptor this equates to a minor adverse effect. **Parking users:** • Medium sensitivity • No impact on on-street parking. • Due to no impact, this equates to negligible effect.
Occupants of Camelford House (Option A only)	**Moderate adverse effect on pedestrians.** **Minor adverse**	**Pedestrians:** • Medium sensitivity • Negligible impact on pedestrian delay • High adverse impact on pedestrian amenity and accidents and safety

Receptors (relating to all identified transport effects)	Significance of effect	Justification (receptor sensitivity and impacts)
	effect on cyclists. **Minor adverse effect on highway users** **Negligible effect on parking users**	• Due to impacts ranging from negligible to high adverse this equates to moderate adverse effect. **Cyclists:** • Medium sensitivity • Negligible impact on cycle delay. • Low adverse impact on accidents and safety. • Due to the mix of minor adverse and negligible impacts, equates to a minor adverse effect **Highway users :** • Medium sensitivity • Negligible impact on road network delay. • Medium adverse impact on accidents and safety. • Low adverse impact from hazardous loads. • Due to negligible, low adverse and medium adverse impact magnitudes and the sensitivity of the receptor this equates to a minor adverse effect. **Parking users:** • Medium sensitivity • Negligible impact on on-street and on-site parking. • Due to negligible impacts, this equates to negligible effect.
Occupants of Tintagel House (Option A only)	Moderate adverse effect on pedestrians. Minor adverse effect on cyclists. Minor adverse effect on highway users Negligible	**Pedestrians:** • Medium sensitivity • Negligible impact on pedestrian delay • High adverse impact on pedestrian amenity and accidents and safety • Due to impacts ranging from negligible to high adverse this equates to moderate adverse effect. **Cyclists:** • Medium sensitivity

Receptors (relating to all identified transport effects)	Significance of effect	Justification (receptor sensitivity and impacts)
	effect on parking users	• Negligible impact on cycle delay. • Low adverse impact on accidents and safety. • Due to the mix of minor adverse and negligible impacts, equates to a minor adverse effect **Highway users :** • Medium sensitivity • Negligible impact on road network delay. • Medium adverse impact on accidents and safety. • Low adverse impact from hazardous loads. • Due to negligible, low adverse and medium adverse impact magnitudes and the sensitivity of the receptor this equates to a minor adverse effect. **Parking users:** • Medium sensitivity • Negligible impact on on-street and on-site parking. • Due to negligible impacts, this equates to negligible effect.
Occupants of Vauxhall Cross Users of recreational spaces at Albert Embankment Gardens Occupants of development at 2-14 Tinworth Street and 108-110 Vauxhall Walk Occupants of Eastbury House Occupants of Riverwalk House Occupants of 1-9 Bondway / 4-6 South Lambeth Place	Moderate adverse effect on pedestrians. Minor adverse effect on cyclists. Minor adverse effect on highway users Negligible effect on parking users	**Pedestrians:** • Medium sensitivity • Negligible impact on pedestrian delay • High adverse impact on pedestrian amenity and accidents and safety • Due to impacts ranging from negligible to high adverse this equates to moderate adverse effect. **Cyclists:** • Medium sensitivity • Negligible impact on cycle delay. • Low adverse impact on accidents and safety. • Due to the mix of minor adverse and negligible impacts, equates to a minor

Receptors (relating to all identified transport effects)	Significance of effect	Justification (receptor sensitivity and impacts)
Occupants of the land at St George's Wharf (Vauxhall Tower) development Occupants of the Hampton House development		adverse effect **Highway users :** • Medium sensitivity • Negligible impact on road network delay. • Medium adverse impact on accidents and safety. • Low adverse impact from hazardous loads. • Due to negligible, low adverse and medium adverse impact magnitudes and the sensitivity of the receptor this equates to a minor adverse effect. **Parking users:** • Medium sensitivity • No impact on on-street parking. • Due to no impact, this equates to negligible effect.
Users of Lacks Dock access road including Duck Tours	Negligible effect	• Medium sensitivity • Negligible impact on road network delay. • Negligible impact equates to negligible effect

12.5.56 With regard to Option B, the only change to the significance of effects would be on occupants of Camelford House and Tintagel House as described in Vol 16 Table 12.5.6.

Vol 16 Table 12.5.6 Transport – significance of effects during construction (Option B only)

Receptors (relating to all identified transport effects)	Significance of effect	Justification (receptor sensitivity and impacts)
Occupants of Camelford House and Tintagel House	Moderate adverse effect on parking users	**Parking users:** • Medium sensitivity. • No impact on on-street parking. • Negligible impact on on-site private parking in Camelford House • High adverse impact on on-site private parking in Tintagel House

Receptors (relating to all identified transport effects)	Significance of effect	Justification (receptor sensitivity and impacts)
		• Due to negligible and high adverse impact, this equates to a moderate adverse effect.

Sensitivity test for programme delay

12.5.57 The assessment has been based on an estimated programme for the construction of the Thames Tideway Tunnel project. That programme has been used to derive construction vehicle numbers and to understand the relationships between the project and other developments in the vicinity of project sites, in order to allow appropriate receptors to be identified.

12.5.58 If the overall programme were to be delayed by approximately a year, the implications in relation to the transport effects would be as follows:

a. It is unlikely that the effects on pedestrians and cyclists would change. Over the course of one year, it is unlikely that pedestrian or cycle traffic in the vicinity of the project site would increase by a sufficient amount to change the magnitude of impacts or the significance of effects reported, nor that the arrangements for pedestrian diversions would be any different to those currently proposed

b. Effects on public transport are unlikely to change as the rate of public transport patronage growth is relatively low and over the course of one year, any reduction in spare capacity on existing public transport networks would be small. Additionally, there is a general trend towards the enhancement of the public transport network through the provision of additional bus, rail and river services in order to meet future demand and accommodate future patronage growth. The transport assessment typically indicates that the additional public transport patronage arising from Thames Tideway Tunnel project sites would be small and not significant in the context of the capacity available on the wider networks

c. Effects on river navigation and access would not be significantly different as the rate of change in patterns of river usage is comparatively small

d. Effects on the operation of the highway network are derived from the use of the TfL Highway Assignment Models (HAMs), which have a forecast model year of 2021. To provide consistency within the assessment, it has been agreed with TfL that this is an appropriate approach. Since the local highway capacity models for the base case also use traffic flow information from the HAMs, it follows that both the strategic and local capacity assessments are effectively based on a year of 2021. As the peak months of activity at the Albert Embankment Foreshore site fall before 2021 based on the programme that has been assessed, it follows that a delay of up to one year would not alter the outcomes of the highway network modelling and therefore would not alter the effects reported

e. Based on the site development schedule (see Vol 16 Appendix N), it is possible that as a result of a one year delay, some developments which have been assumed to be under construction in this assessment (see para. 12.3.7) would be partially complete and occupied. However, it is not expected that new receptors would experience any different effects to those receptors which have been assessed above; rather it would be a case of the potential for some additional receptors to experience the same effects that have already been identified.

12.6 Operational effects assessment

12.6.1 This section summarises the findings of the assessment undertaken for Year 1 of operation at the Albert Embankment Foreshore site.

12.6.2 The transport demands created by the development in the operational phase would be extremely low and limited to occasional maintenance visits every three to six months and larger cranes and other associated support vehicles required for access to the shaft and tunnel every ten years.

12.6.3 The assessment of the operational phase is therefore limited to the physical issues associated with accessing the site from the highway network as outlined in Section 12.2. This has been agreed with the LB of Lambeth and TfL.

12.6.4 The operational assessment has taken into consideration those elements that would be affected, which comprise the short-term impacts on the highway operation and pedestrian routes when maintenance visits are made to the site.

Pedestrians

12.6.5 A new public realm area would be created in the foreshore to the west of Camelford House and Vauxhall Cross, effectively widening the Thames Path at this location. The permanent highway layout plan (see separate volume of figures – Section 1) shows the highway layout during the operational phase.

12.6.6 Large vehicles would be required to access the section of the operational site to the west of Camelford House for maintenance purposes on an occasional basis. Vehicles would use a section of the Thames Path to the southwest of Camelford House and the new public realm area to the west of Camelford House in order to gain access. As a result, pedestrians would not be able to use this section of the Thames Path when maintenance is taking place. This temporary closure of the Thames Path would occur every three to six months and the closure would last one day. When larger cranes are required to access the shaft and tunnel every ten years, the Thames Path would be closed for two weeks.

12.6.7 Based on the impact magnitude criteria outlined in Vol 2 the provision of a new public realm area would result in a high beneficial impact on pedestrian amenity. However, taking into consideration the infrequent/temporary closure of a section of the Thames Path and the sensitivity of the receptor, it is anticipated that overall there would be a medium beneficial impact for pedestrians, which would equate to a **moderate beneficial** effect.

Highway operation

12.6.8 For routine three or six monthly inspections vehicular access would be required for light commercial vehicles, typically a transit van. On occasion there may also be a need for small flatbed vehicles to access the site.

12.6.9 The site would be accessed via Albert Embankment (A3036) from the northbound carriageway during the operational phase. Vehicles would route along the Lacks Dock slipway and then a section of the Thames Path to the southwest of Camelford House to reach the tunnel shaft which would be located in the new public realm area to the west of Camelford House.

12.6.10 During ten-yearly inspections, space to locate two large cranes within the site area to the west of Camelford House would be required. The cranes would facilitate lowering and recovery of tunnel inspection vehicles and to provide duty/standby access for personnel. To assess the effect of these on the highway layout, swept paths have been undertaken for the largest vehicles expected to require access; an 11.36m mobile crane, a 10m articulated vehicle and a 10.7m articulated vehicle. The permanent highway layout swept path vehicle analysis plan (see Albert Embankment Foreshore Transport Assessment Figures) demonstrates that operational vehicles would be able to safely enter and leave the site.

12.6.11 When larger vehicles are required to service the site there may be some temporary, short-term delay to other road users while manoeuvres are made. However it is anticipated that the arrival of large vehicles would normally be scheduled to take place outside of the peak hours to minimise the effect on the local highway network.

12.6.12 There may also be some temporary, short-term delay to Duck Tours vehicles accessing and egressing the foreshore via Lacks Dock as this is the route that maintenance vehicles would use to reach the operational site.

12.6.13 In accordance with the criteria outlined in Vol 2, during the routine inspections of the operational site it is anticipated that there would be a negligible impact on road network delay.

12.6.14 Taking into consideration the various sensitivities of the receptors affected during the operational phase (cyclists, private vehicle users, emergency vehicles, bus users and users of Lacks Dock) this would result in a **negligible** effect on highway layout and operation.

Sensitivity test for programme delay

12.6.15 If the opening year of the Thames Tideway Tunnel were to be delayed by approximately one year, the results of the operational assessment would not be materially different to the assessment findings reported above.

12.7 Cumulative effects assessment

Construction effects

12.7.1 As listed in para. 12.3.7, there are a number of developments in the vicinity of the Albert Embankment Foreshore site that would be under construction at the same time. This suggests that there are cumulative effects to assess for the construction development case. However, as para. 12.3.9 explains, the TfL HAMs which have been used in the assessment already take account of population and employment growth forecasts in London.

12.7.2 In addition, specific allowance has been made in the local highway modelling for the construction trips generated by the committed developments in para. 12.3.6, where that information is available.

12.7.3 This approach addresses a number of uncertainties around the actual timescale for implementation of each of the committed developments and thus inherently addresses cumulative effects within the assessment of construction effects reported in Section 12.5. The effects on transport would therefore remain as described in that section. This would also be the case if the programme for the Thames Tideway Tunnel project were delayed by approximately one year.

Operational effects

12.7.4 As indicated in the site development schedule (see Vol 16 Appendix N) and as identified in liaison with TfL and LB Wandsworth, the developments stated in paras. 12.3.19-12.3.20 are in the vicinity of the Albert Embankment Foreshore site would be under construction or operational by Year 1 of operation.

12.7.5 However, as maintenance trips to the Albert Embankment Foreshore site would be low and the trips from the developments identified above are already taken into account within the assessment, there is no need for a cumulative assessment on transport and the effects would remain as described in Section12.6. This would also be the case if the programme for the Thames Tideway Tunnel project were delayed by approximately one year.

12.8 Mitigation

12.8.1 The project has been designed to limit the effects on transport networks as far as possible and many measures have been embedded directly in the design of the project.

Construction

12.8.2 During construction it is envisaged that the embedded measures set out in Section 12.2, including the *CoCP* and *Draft Project Framework Travel Plan*, would minimise the effects resulting from construction works at the Albert Embankment Foreshore site.

12.8.3 These are the most appropriate measures for this site and it is not possible to mitigate all significant effects.

Operation

12.8.4 No mitigation is required during the operational phase.

12.9 Residual effects assessment

Construction effects

12.9.1 As no mitigation measures are proposed the residual construction effects remain as described in Section 12.5. All residual effects are presented in Section 12.10.

Operational effects

12.9.2 As no mitigation measures are proposed the residual operational effects remain as described in Section 12.6. All residual effects are presented in Section 12.10.

12.10 Assessment summary

Vol 16 Table 12.10.1 Transport – summary of construction assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Pedestrians (including sensitive pedestrians) using the Thames Path and Albert Embankment (A3036) footways.	• Loss of footway • Pedestrian diversion route • Decreased journey distance but increased journey time due to additional signalised crossing	Moderate adverse effect	None	Moderate adverse effect
Cyclists routing northbound along Albert Embankment (A3036)	• Movement of large construction vehicles	Minor adverse effect	None	Minor adverse effect
Private vehicles in the area using the local highways or on-street parking.	• Movement of large construction vehicles • No effect on on-street parking in the vicinity of the site.	Minor adverse effect on highway users Negligible effect on parking users	None	Minor adverse effect on highway users Negligible effect on parking users
Emergency vehicles travelling on Albert Embankment (A3036)	• Movement of large construction vehicles	Minor adverse effect	None	Minor adverse effect
Bus users (passengers) travelling northbound along Albert Embankment (A3036).	• Movement of large construction vehicles • Some additional patronage from construction workers	Negligible effect	None	Negligible effect
River vessel operators	• Some additional barge	Negligible effect	None	Negligible effect

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
including river passenger services.	movements on the River Thames			
Public transport users using rail or river services within the area.	• Some additional patronage from construction workers.	Negligible effect	None	Negligible effect
Occupants of Camelford House (Option A only) Occupants of Tintagel House (Option A only)	• Movement of large construction vehicles • No effect on on-street parking • Removal of two parking bays in Camelford House car park	Moderate adverse effect on pedestrians. Minor adverse effect on cyclists. Minor adverse effect on highway users Negligible effect on parking users	None	Moderate adverse effect on pedestrians. Minor adverse effect on cyclists. Minor adverse effect on highway users Negligible effect on parking users
Residents of Bridge House Occupants of Vauxhall Cross Users of recreational spaces at Albert Embankment Gardens Occupants of development at 2-14 Tinworth Street and 108-110 Vauxhall Walk Occupants of Eastbury	• Movement of large construction vehicles • No effect on on-street parking	Moderate adverse effect on pedestrians. Minor adverse effect on cyclists. Minor adverse effect on highway users Negligible effect on parking users	None	Moderate adverse effect on pedestrians. Minor adverse effect on cyclists. Minor adverse effect on highway users Negligible effect on parking users

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
House Occupants of Riverwalk House Occupants of 1-9 Bondway / 4-6 South Lambeth Place Occupants of the St George's Wharf (Vauxhall Tower) development Occupants of the Hampton House development				
Users of Lacks Dock access road including Duck Tours	• Movement of large construction vehicles • Highway layout changes • Delay to journey time.	Negligible effect	None	Negligible effect

Vol 16 Table 12.10.2 Transport – summary of construction assessment (Option B only)

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Occupants of Camelford House and Tintagel House	• Reduction in on-site private parking	Moderate adverse effect on parking users	None	Moderate adverse effect on parking users

Vol 16 Table 12.10.3 Transport – summary of operational assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Pedestrians using the Thames Path and new public realm to the west of Camelford House.	• New public realm area • Occasional closure of a section of the Thames Path and public realm for vehicle access and maintenance activities during maintenance phase.	Moderate beneficial effect	None	Moderate beneficial effect
Cyclists travelling on Albert Embankment (A3036) Private vehicle users in the area using the local highways or on-street parking. Emergency vehicles travelling on Albert Embankment (A3036). Bus users (passengers) travelling northbound along Albert Embankment (A3036). Users of Lacks Dock access road including Duck Tours	• Occasional delay to road users when large maintenance vehicles accessing site.	Negligible effect	None	Negligible effect

References

[1] Defra, *National Policy Statement for Waste Water,* 2012.

[2] Transport for London, *Travel Planning for new development in London,* 2011.

[3] Transport for London, *Assessment Tool for Travel Plan Building Testing and Evaluation (ATTrBuTE)*, 2011. Available at: http://www.attrbute.org.uk/

[4] Greater London Authority, *London Plan*, July 2011.

[5] Transport for London, *Transport Assessment Best Practice Guidance*, April 2010.

[6] The estimates are derived from study team calculations that use the arrival and departure times for piers published in TfL River Bus and Tour timetables (http://www.tfl.gov.uk/modalpages/2648.aspx) and information on barge movements obtained from barge operators and commercial users.

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.16**

Volume 16: Albert Embankment Foreshore site assessment

Section 13: Water resources - groundwater

APFP Regulations 2009: Regulation **5(2)(a)**

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Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

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Thames Tideway Tunnel

Environmental Statement

Volume 16: Albert Embankment Foreshore site assessment

Section 13: Water resources – groundwater

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13 Water resources – groundwater

13.1 Introduction

13.1.1 This section presents the findings of the assessment of the likely significant effects of the proposed development on groundwater at Albert Embankment Foreshore site.

13.1.2 The proposed development has the potential to affect groundwater due to:

a. dewatering of aquifer units

b. creation of pathways for pollution

c. obstruction to groundwater flows

d. seepage into and out of the CSO drop shaft during operations.

13.1.3 The groundwater assessment at this site should be read in conjunction with the supporting Vol 16 Appendix K and the land quality assessment (see Section 8 Land quality).

13.1.4 No major dewatering would be required at the Albert Embankment Foreshore site as the drawdown from pumping at a nearby main tunnel site would lower groundwater levels at this site. Dewatering nearby Kirtling Street main tunnel site would assist the depressurisation[i] of the Lambeth Group, although a series of ejector wells (small volume wells) may be required outside the perimeter of the diaphragm wall[ii] to reduce heave (uplift) during shaft construction. The small amount of additional dewatering may be required locally during shaft construction at the Albert Embankment Foreshore site.

13.1.5 An assessment of project-wide environmental effects on groundwater is presented in Volume 3 Project-wide assessment.

13.1.6 The assessment of groundwater presented in this section has considered the requirements of the National Policy Statement for Waste Water (Defra, 2012)[1] Section 4.2. The physical characteristics of the groundwater environment including groundwater resources and quality are presented and the anticipated effects (including cumulative effects) on these resources addressed in the assessment that follows (further detail can be found in Vol. 2 Section 13.3).

13.1.7 Plans of the proposed development as well as figures included in the assessment for this site are contained in a separate volume (Volume 16 Albert Embankment Foreshore Figures).

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[i] Depressurisation – a term used to describe dewatering or lowering of hydraulic pressures in a confined aquifer.

[ii] Diaphragm wall – a sub-surface barrier installed around construction works to support the required excavation and which amongst other things helps to control inflows of groundwater typically formed of reinforced concrete. This barrier would extend down by up 8m below the base of the shaft invert, for structural reasons and to increase the length of the flow path and hence reduce the amount of groundwater inflows

13.1.8 Two access options have been considered: Option A is via Lack's Dock and Option B involves the construction of a temporary road access between Camelford House and Tintagel House. Neither option would alter the assessment of likely significant effects on ground water as they would not impact on groundwater resources at the Albert Embankment Foreshore site. The options are therefore not presented or reported separately for this topic.

13.2 Proposed development relevant to groundwater

13.2.1 The proposed development has been described in Section 3 of this volume. The elements of the proposed development relevant to groundwater are set out below.

Construction

13.2.2 The elements of construction at the Albert Embankment Foreshore site would include:

a. A drop shaft of approximately 16m internal diameter (ID) and approximately 47m deep (or 57.47mATD[iii] based on an assumed ground level of 104.6mATD) (excluding an approximately 3m thick base slab once constructed).

b. An interception chamber for the two existing CSOs, the Clapham Storm Relief CSO and the Brixton Storm Relief CSO.

c. A connection culvert from the interception chamber to the CSO drop shaft.

d. Two new sections of river wall.

e. A short connection tunnel from the CSO drop shaft to the main tunnel.

f. Two temporary cofferdams in the foreshore.

13.2.3 The proposed methods of construction for these elements of the site are described in Section 3 of this volume and approximate duration of construction and depths are also contained in Vol 16 Table 13.2.1 below.

Vol 16 Table 13.2.1 Groundwater – methods of construction

Design element	Method of construction	Construction periods (in years)*	Construction depth** (mbgl)
CSO drop shaft	Diaphragm wall and dewatering	<1	Deep

[iii] In general, the measurements of depth are expressed as metres Above Tunnel Datum (mATD). The standard zero point for mATD scale is -100maOD (metres above Ordnance Datum is based on Newlyn datum point for mean sea level). The use of the mATD scale avoids the need for use of negative values, and is widely used for large scale sub-surface projects

Design element	Method of construction	Construction periods (in years)*	Construction depth** (mbgl)
Interception chambers	Secant piling[iv] or sheet pile[v] box within cofferdam	<1	Deep
Connection culvert to CSO drop shaft	Sprayed Concrete Lining (SCL)	<1	Deep
Connection tunnel from the CSO drop shaft to main tunnel	SCL with depressurisation	<1	Deep
Cofferdam	Sheet pile walls with internal dewatering	1-2 years	Shallow

** The site would be used for construction purposes for up to 3 and a half years*
*** In terms of construction depth – shallow (means <10m) and deep (>10m).*

Code of Construction Practice

13.2.4 All works would be undertaken in accordance with the *Code of Construction Practice (CoCP*). The CoCP is provided in Vol 1 Appendix A. It contains general requirements (Part A), and site specific requirements for this site (Part B). The relevant measures included within the *CoCP* Part A to ensure that adverse effects on groundwater are minimised as follows:

a. Measures include providing bunded stores for fuel/oils held on site and the settlement of water from excavations to prevent silty water from entering watercourses, surface water drains and onto roads as per Environment Agency guidelines (EA, 2011)[2]. The contractor would have plans and equipment in place to deal with emergency situations as well as ensuring that staff are appropriately trained.

b. A precautionary approach, involving targeted risk-based audits and checks by monitoring water quality, would be applied to licensed abstractions thought to be at risk.

c. Monitoring arrangements for any permits required on change of licensing regulations would be developed in liaison with the EA (see also the groundwater monitoring strategy in Vol 3 Appendix K.1).

d. The use of any materials for ground treatment would be agreed with the EA prior to use.

e. At the end of construction where temporary support does not form part of the operational structure it would be removed, piped through or cut

[iv] Secant piles – a sub-surface structure installed to support excavation and which amongst other things helps to control inflows of shallow groundwater typically formed of overlapping concrete piles.

[v] Sheet pile wall – a sub-surface structure installed to support excavation and which amongst other things helps to control inflows of shallow groundwater typically formed of steel sheets.

down to avoid the build up of groundwater on the upstream side of underground structures.

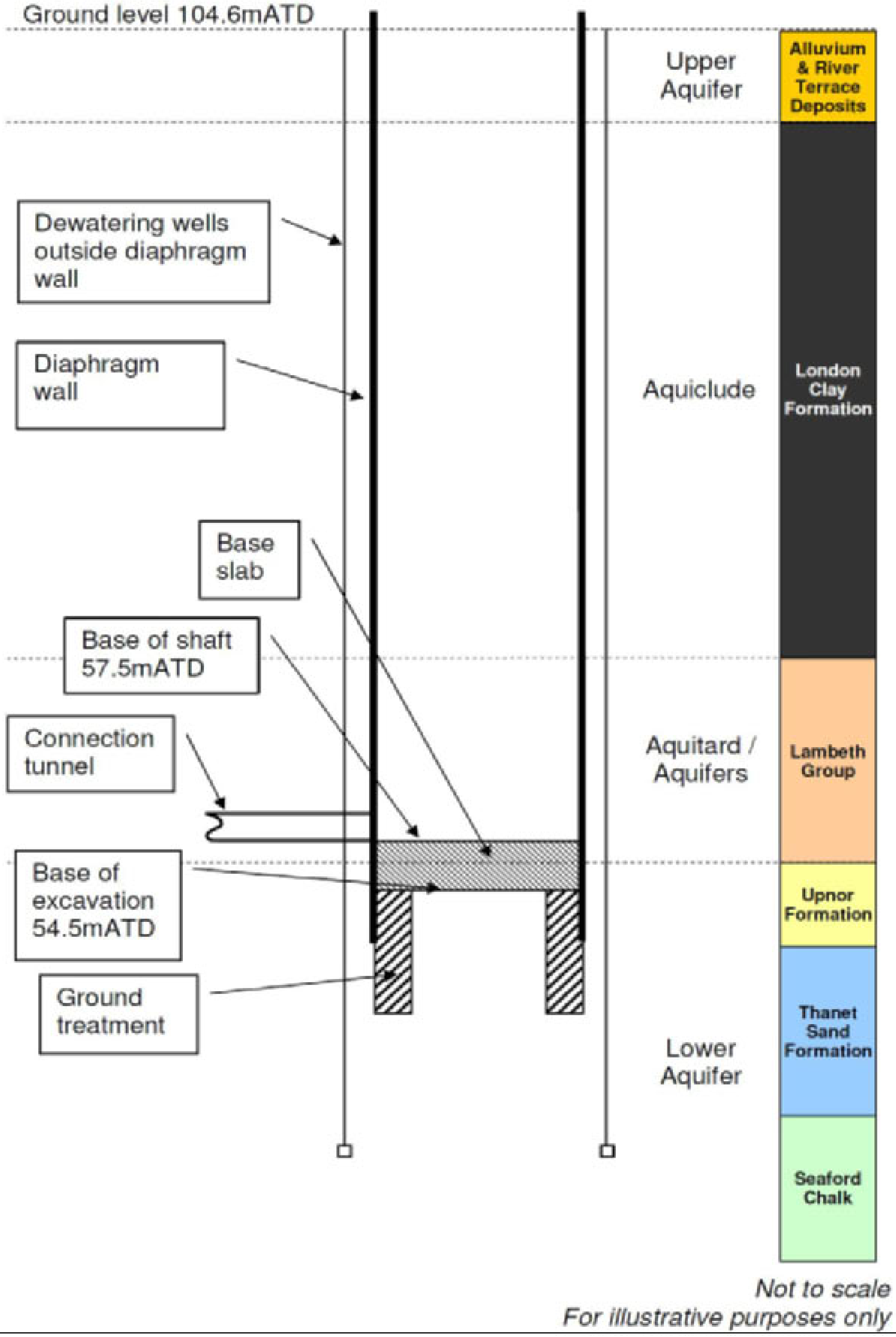
13.2.5 There are no site specific ground measures contained within the *CoCP Part B*.

Other measures during construction

13.2.6 The depth of the CSO drop shaft means that it would extend down into the Lower Mottled Beds of the Lambeth Group (see Vol 16 Appendix K.1), with the base slab extending down into the Upnor Formation.

13.2.7 The method of construction for the CSO drop shaft would involve building a concrete barrier around the shaft (a diaphragm wall). There would be pumping external to the diaphragm wall, in order to prevent potential heave (upward movement) at the base of the CSO drop shaft during construction. A small number of dewatering wells would be drilled into the Lambeth Group around the outside periphery of the diaphragm walled shaft and pumped to lower the pressure (see Vol 16 Plate 13.2.1). The periods when pumping would be required would be during construction of the CSO drop shaft and for the short connection tunnel from the CSO drop shaft to the main tunnel.

Vol 16 Plate 13.2.1 Groundwater – Simplified drawing of a diaphragm wall with external dewatering



13.2.8 The project-wide dewatering of the lower aquifer at a nearby Kirtling Street main tunnel site would generate most of the depressurisation of the Lambeth Group and dewatering of the Upnor Formation at the Albert Embankment Foreshore site by under-draining the Chalk (see Section 13.5).

13.2.9 A small amount of additional dewatering, of less than 200m^3/d, would also be needed at Albert Embankment Foreshore.

13.2.10 For the purpose of this assessment no dewatering of the upper aquifer is anticipated. Instead a secant or sheet piling into the London Clay Formation would be constructed at the Albert Embankment Foreshore interception chamber which would seal out groundwater in the River Terrace Deposits (upper aquifer).

13.2.11 Ground treatment[vi] is anticipated to be required at the toe of the diaphragm wall used for construction of the CSO drop shaft, and may also be required for the short connection to the main tunnel. This ground treatment would be within the Lower Mottled Beds of the Lambeth Group. While grouting[vii] has the potential to introduce contaminants, such as turbidity, into groundwater and to deteriorate groundwater quality, any grouting products used would be approved by the EA.

13.2.12 The site would extend partly into the River Thames and this part of the site would be protected from inundation by a temporary cofferdam. The cofferdam could be constructed from two sheet pile walls. The toe level of the sheet piles would be into the London Clay Formation at 93mATD. Water entering through the cofferdam would be pumped back to the river following any required treatment. It is assumed that the sheet piles would be removed at the end of the construction period.

Operation

13.2.13 A groundwater monitoring strategy is one of the project's environmental design measures (see Vol 3 Appendix K.1). This covers groundwater levels and groundwater quality, and would outline the future monitoring and actions in the event of trigger levels being exceeded.

13.3 Assessment methodology

Engagement

13.3.1 Vol 2 Environmental assessment methodology documents the overall engagement which has been undertaken in preparing the *Environmental Statement*. There were no site-specific comments relevant to the assessment of groundwater for the Albert Embankment Foreshore site.

[vi] Ground treatment – stabilisation of soils/rocks by injection of grouts and or freezing techniques.

[vii] Grouting - a thin, coarse mortar injected into various narrow cavities or voids , such as rock fissures, to fill them and consolidate the adjoining objects into a solid mass and to eliminate water.

Baseline

13.3.2 The baseline methodology follows the methodology described in Vol 2. There are no site-specific variations for identifying the baseline conditions for this site.

13.3.3 The baseline describes receptors within a 1km radius of the site.

Construction

13.3.4 The assessment methodology for the construction phase follows that described in Vol 2. There are no site-specific variations for undertaking the construction assessment of the Albert Embankment Foreshore site.

13.3.5 The assessment year applied to the construction assessment is Site Year 1 of construction, when the diaphragm wall or piling could obstruct groundwater flows with small scale pumping outside both these structures and towards the end of that year when pumping outside the diaphragm wall would be greatest in order to prevent heave from acting on the shaft. The baseline is not anticipated to change substantially between 2011 and Site Year 1 of construction (2017) and so baseline data from 2011 have formed the basis (base case) for the construction assessment.

13.3.6 A number of proposed developments which are likely to be complete and operational before commencement of construction have formed part of the construction base case.

13.3.7 The developments considered as part of the base case and those included in the cumulative effects assessment are presented in Vol 16 Table 13.3.1 below. The developments relevant to groundwater are those which would contain basements, Ground Source Heat Pumps (GSHP's) or Sustainable Drainage Systems (SuDS).

Vol 16 Table 13.3.1 Groundwater – construction base case and cumulative assessment developments (2017)

Development	Component or receptor relevant to groundwater	Construction base case	Cumulative impact assessment
10 Albert Embankment	Basement*	✓	✗
1-9 Bondway and 4-6 South Lambeth Place	Basement*	✓	✗
2-14 Tinworth Street, and 108 - 110 Vauxhall Walk	Basement*	✓	✗
30 - 60 South Lambeth Road	Basement*	✗	✓
81 Black Prince Road (Parliament House)	Basement*	✓	✗
Battersea Plant, Nine Elms Lane Goods Yard, Cringle Street	None	✗	✗

Development	Component or receptor relevant to groundwater	Construction base case	Cumulative impact assessment
Eastbury House, 30 - 34 Albert Embankment	Basement*	✓	✗
Embassy Gardens, Land to the south of Nine Elms Lane comprising DHL Depot and 1-12 Ponton Road and 51 Nine Elms Lane	Basement* SuDS*	Buildings A09, A10 & A11 complete	Buildings A01, A02, A03, A04, A05 & A07 under construction
Hampton House, 20 Albert Embankment London	Basement*	✓	✗
Island Site Vauxhall Cross	Basement*	✗	✓
Land at St Georges Wharf (Vauxhall Tower)	Basement* GSHP**	✓	✗
Market Towers	Basement*	✓	✗
Nine Elms Pier	None	✗	✗
Nine Elms Sainsbury's, Wandsworth Road	Basement*	✓	✗
Northern Line Extension	Underground structures*	✗	✓
Post Office Depot, South London Mail Centre Nine Elms Lane	Basement*	✗	Plots B, C & D under construction
Riverwalk House redevelopment	Basement*	✓	✗
US Embassy - Land on south side of Nine Elms Lane incorporating Ponton Road	Basement*	✓	✗
Vauxhall Sky Gardens, 143-161 Wandsworth Road	Basement*	✓	✗
Vauxhall Square Cap Gemini Site (plot bounded by Parry Street, Bondway, Miles Street and Wandsworth Road)	Basement*	✗	✓

** Relevant to the upper aquifer*
*** Relevant to the lower aquifer*
Symbols ✓ applies ✗ does not apply

13.3.8 Section 13.5 details the likely significant effects arising from the construction at the Albert Embankment Foreshore site. Other nearby Thames Tideway Tunnel project site which could give rise to additional effects on groundwater resources is Kirtling Street and Blackfriars Bridge Foreshore. This Thames Tideway Tunnel project site is therefore included in this assessment of the impact of dewatering on the lower aquifer and licensed abstractions at the Albert Embankment Foreshore, following the methodology set out in Vol 2 Section 13.

Operation

13.3.9 The assessment methodology for the operation phase follows that described in Vol 2. There are no site-specific variations for undertaking the operational assessment of this site.

13.3.10 The assessment year applied to the operational assessment is Year 1 of operation (2023). The baseline is not anticipated to vary significantly before the start of the operational phase in 2023; and therefore, baseline data from 2011 has formed the basis for the operational assessment. In addition, information on proposed development schemes likely to have been completed before commencement of the operation at the Thames Tideway Tunnel project has formed part of the operational base case.

13.3.11 The developments considered as part of the operational base case and the cumulative effects assessment is included in Vol 16 Table 13.3.2 below. The receptors relevant to groundwater are those which would contain basements, GSHP's or SuDS.

Vol 16 Table 13.3.2 Groundwater – operational base case and cumulative assessment developments (2023)

Development	Component or receptor relevant to groundwater	Operational base case	Cumulative impact assessment
10 Albert Embankment	Basement*	✓	✗
1-9 Bondway and 4-6 South Lambeth Place	Basement*	✓	✗
2-14 Tinworth Street, and 108 - 110 Vauxhall Walk	Basement*	✓	✗
30 - 60 South Lambeth Road	Basement*	✓	✗
81 Black Prince Road (Parliament House)	Basement*	✓	✗
Battersea Plant, Nine Elms Lane Goods Yard, Cringle Street	None	✓	✗
Eastbury House, 30 - 34 Albert Embankment	Basement*	✓	✗
Embassy Gardens, Land to	Basement* SuDS*	✓	✗

Development	Component or receptor relevant to groundwater	Operational base case	Cumulative impact assessment
the south of Nine Elms Lane comprising DHL Depot and 1-12 Ponton Road and 51 Nine Elms Lane			
Hampton House, 20 Albert Embankment London	Basement*	✓	✗
Island Site Vauxhall Cross	Basement*	✓	✗
Land at St Georges Wharf (Vauxhall Tower)	Basement* GSHP**	✓	✗
Market Towers	Basement*	✓	✗
Nine Elms Pier	None	✓	✗
Nine Elms Sainsbury's, Wandsworth Road	Basement*	✓	✗
Northern Line Extension	Underground structures*	✓	✗
Post Office Depot, South London Mail Centre Nine Elms Lane	Basement*	Plots A, B, C, & D Complete	Plots E, F, & G under construction
Riverwalk House redevelopment	Basement*	✓	✗
US Embassy - Land on south side of Nine Elms Lane incorporating Ponton Road	Basement*	✓	✗
Vauxhall Sky Gardens, 143-161 Wandsworth Road	Basement*	✓	✗
Vauxhall Square Cap Gemini Site (plot bounded by Parry Street, Bondway, Miles Street and Wandsworth Road)	Basement*	✓	✗

** Relevant to the upper aquifer*
*** Relevant to the lower aquifer*
Symbols ✓ applies ✗ does not apply

13.3.12 Section 13.6 details the likely significant effects arising from the operation at the Albert Embankment Foreshore site. There are no other Thames Tideway Tunnel project sites which could give rise to additional effects on groundwater resources within the assessment area for this site during the operational phase and so no other Thames Tideway Tunnel project sites are considered in this assessment.

Assumptions and limitations

Assumptions

13.3.13 The construction assumptions relevant to this site are presented in Section 13.2.

13.3.14 The assessment of dewatering in Section 13.5 is based on a quantitative assessment of dewatering on the lower aquifer using the best available hydraulic property information from the EA's London Basin groundwater model. The hydraulic properties for the Chalk obtained from this model, include an average transmissivity value of approximately 450m^2/d (EA and ESI, 2010) [3] and a storativity[viii] value of approximately 1 x10^{-4} at the Albert Embankment Foreshore site (see Vol 2 Section 13).

13.3.15 The amount of pumping required from outside the diaphragm wall at the Albert Embankment Foreshore site is assumed to be less than 200m^3/d.

13.3.16 The assessment of obstruction effects in Sections 13.5 and 13.6 is based on estimated hydraulic gradient[ix] of 0.004 in the upper aquifer across the site.

13.3.17 The upper aquifer is assumed to be in hydraulic continuity with the overlying layers, Alluvium and Made Ground.

13.3.18 The regional groundwater flow direction in the Chalk is based on the EA groundwater contour map (EA, 2011b)[4] and this indicates flow towards the northwest.

13.3.19 This assessment has assumed that the shaft would have a design criterion to limit the rate of seepage of 1l/m^2/d (see Vol 2 Appendix K.3).

13.3.20 The measurements of the depth of shafts are quoted to two decimal places, however these measurements may be altered slightly in the future and are therefore indicative only.

13.3.21 For the purposes of this assessment, deep refers to greater than 10m below ground level (bgl) and shallow refers to less than 10m bgl.

13.3.22 For the purposes this assessment, it is assumed that non-infiltration type SuDS will be used on any neighbouring developments which take place locally.

Limitations

13.3.23 No site-specific pumping tests have yet been undertaken as part of the ground investigation. In the absence of site-specific hydrogeological data, published sources of hydrogeological information have been used in this assessment (see Vol 16 Appendix K).

13.3.24 Groundwater level data available for this assessment is limited, with no boreholes monitoring groundwater levels at the site. Monitoring data was available from two boreholes within the upper and lower aquifers located a short distance away at a neighbouring site. This means that hydraulic

[viii] Storativity – the volume of water released for a unit change in water level (in a confined aquifer).

[ix] Hydraulic gradient – the slope of the water table which drives groundwater movement.

gradients could only be estimated across the site. In addition, the range of hydrological conditions experienced during the monitoring period (2010-2012) did not include a prolonged wet winter period when exceptionally high groundwater conditions might occur.

13.3.25 Despite the limitations identified above, the assessment, which uses the best available information, is considered robust.

13.4 Baseline conditions

13.4.1 The following section sets out the baseline conditions for groundwater within and around the site. Future baseline conditions (base case) are also described.

13.4.2 This section of the assessment is supported by Vol 16 Appendix K.

Current baseline

Hydrogeology

13.4.3 The CSO drop shaft would pass through Alluvium, River Terrace Deposits, London Clay Formation, Harwich Formation and Lambeth Group. The superficial and solid geology in the vicinity of the site, as published by the British Geological Survey (BGS, 2009)[5], is shown in Vol 16 Figure 13.4.1 and Vol 16 Figure 13.4.2 respectively (see separate volume of figures).

13.4.4 The River Terrace Deposits form the upper aquifer and are classified by the EA as a secondary A aquifer[x]. The lower aquifer comprises the Upnor Formation, Thanet Sands and the Chalk, and is classified as a principal aquifer[xi].

13.4.5 Drilling took place during 2009 in the vicinity of the Albert Embankment Foreshore site. The depths and thicknesses of the geological layers are summarised in Vol 16 Table 13.4.1 below. Made Ground is not present in this table due to the ground conditions having been anticipated from over-water boreholes near to the site. Made Ground may also be expected on any parts of the site lying inside the existing river wall at the Albert Embankment Foreshore site.

Vol 16 Table 13.4.1 Groundwater – anticipated ground conditions/ hydrogeology

Formation	Top elevation* (mATD)	Depth below river bed (m)	Thickness (m)	Hydrogeology
Alluvium	101.20	0.00	1.20	Hydraulic continuity with upper aquifer

[x] Secondary aquifer – Either permeable strata capable of supporting local supplies or low permeability strata with localised features such as fissures (was previously preferred to as a minor aquifer).

[xi] Principal aquifer – a geological stratum that exhibits high inter-granular and /or fracture permeability was previously referred to as a major aquifer)

Formation	Top elevation* (mATD)	Depth below river bed (m)	Thickness (m)	Hydrogeology
River Terrace Deposits	100.00	1.20	2.90	Upper aquifer
London Clay	97.10	4.10	27.90	Aquiclude[xii]
Harwich	69.20	32.00	0.40	Aquitard/[xiii] aquifer
Lambeth Group				
USB	68.80	32.40	1.30	Aquitards/ aquifers
UMB	67.50	33.70	5.30	
Sand Channel	62.20	39.00	2.30	
LtB/LSB	59.90	41.30	0.40	
LMB	59.50	41.70	4.40	
UPN (Gv)	55.10	46.10	3.20	Lower aquifer
UPN	51.90	49.30	1.10	
Thanet Sand	50.20	49.80	9.20	
Seaford Chalk	41.00	59.00	Not proven	

** Based on an assumed ground level of ground level assumed at 104.6mATD and top elevation of over-water boreholes is approximately 4.6m below assumed ground level*
*** It has been assumed that the made ground and alluvium are in hydraulic connectivity for the purposes of this assessment.*
Note - USB–Upper Shelly Beds; UMB–Upper Mottled Beds; LtB–Laminated Beds; LSB-Lower Shelly Beds; LMB-Lower Mottled Beds; UPN (Gv)-Upnor Formation(Gravel); UPN-Upnor Formation.

13.4.6 Groundwater inflows are also expected during excavation within the Laminated Beds (LtB) in the Lambeth Group (potentially sizeable volumes) and within the Upper Mottled Beds (UMB) (potentially smaller inflows).

13.4.7 The Upnor Formation, Thanet Sands and Chalk are all in hydraulic connection and form the lower aquifer. It is expected that once the Upnor Formation is reached during CSO drop construction that substantial quantities of groundwater under pressure would be encountered.

Groundwater level monitoring

13.4.8 Groundwater level monitoring has been undertaken at a number of boreholes across the assessment area (1km radius of the site). In addition, the EA has a regional network of monitoring boreholes, mainly within the lower aquifer, across London with groundwater level records available dating back over 50 years.

13.4.9 The information on groundwater levels for this assessment has been collected from two ground investigation boreholes (SR1078 and SR1070) located within the assessment area (at 50 and 120m from the site). These boreholes have response zones[xiv] (EA, 2006)[6] in the Alluvium/River Terrace Deposits, Thanet Sands and Chalk and are monitoring groundwater levels in both the upper and lower aquifer. The locations are shown in Vol 16 Figure 13.4.3 (see separate volume of figures). Vol 16 Table 13.4.2 below summarises the minimum, average and maximum water levels at the two ground investigation boreholes.

Vol 16 Table 13.4.2 Groundwater – recorded water levels

Monitoring borehole ID	Formation	Average (mATD)	Minimum (mATD)	Maximum (mATD)
SR1078	Alluvium/ River Terrace Deposits	99.26	98.63	99.86
SR1070	Thanet Sands	71.09	68.18	74.49
TQ27_334	Seaford Chalk	70.80	57.33	79.65

13.4.10 The recorded water levels in the Alluvium / River Terrace Deposits at SR1078, fluctuates below the top of the horizon indicating that this aquifer is not fully saturated at this site. This means that this storage is potentially available to cope with any rise in groundwater level caused by obstruction effects.

13.4.11 The recorded water levels (piezometric head[xv]) in the Thanet Sands at SR1070 remain above the top of the lower aquifer (Upnor Formation, Thanet Sands and Chalk) at 55.1mATD, indicating confined[xvi] conditions beneath the overlying London Clay Formation and Lambeth Group at this site. The piezometric levels in the Upnor Formation are likely to be similar (to the Thanet Sand) as these units are in hydraulic continuity.

13.4.12 The EA produces an annual regional groundwater contour map (piezometry) of the Chalk, showing a snap-shot of groundwater flows in time (EA, 2011b)[7] (see (Vol 16 Plate 13.4.1). The January 2011 map indicates that the regional direction of groundwater flow (perpendicular to groundwater contours) at this point in times was towards the northwest in the Chalk around the Albert Embankment Foreshore site. However it is likely that the influence of the nearby Chalk abstractions (see para. 13.4.15) would affect the direction of regional groundwater flow beneath the site. The location of the closest EA groundwater level monitoring borehole, and its respective hydrograph, is shown in Vol 14 Figure 13.4.4 (see separate volume of figures).

13.4.13 As there is one monitoring borehole within the River Terrace Deposits, it is not possible to accurately determine the direction of groundwater flow in

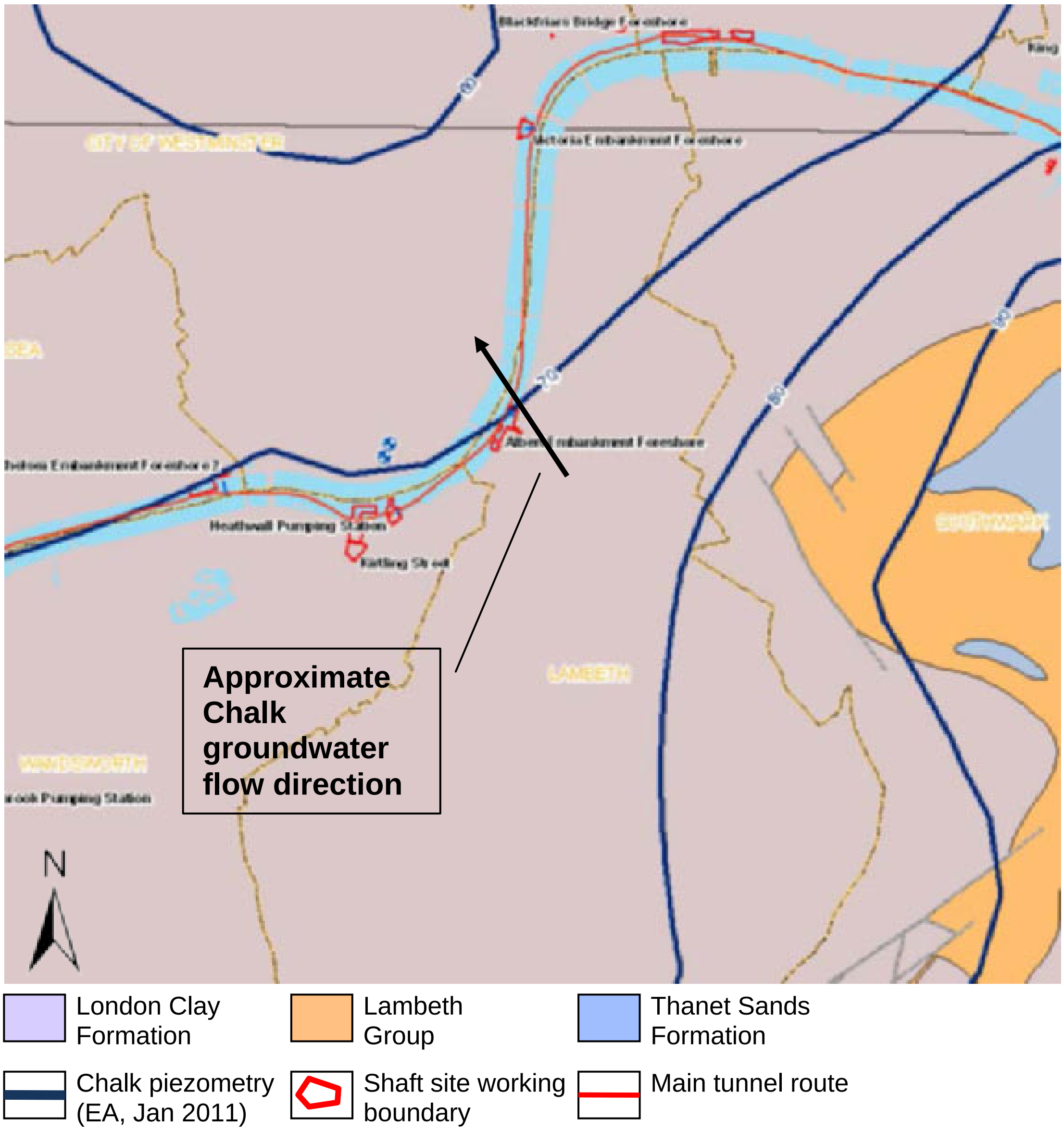
[xiv] Response zone – the section of a borehole that is open to the host strata (EA, 2006)

[xv] Piezometric head - this is level to which water would rise to if there is a free surface open to the atmosphere.

[xvi] Confined - a term used to describe an aquifer in which water is held under pressure, such that groundwater in a borehole penetrating a confined aquifer would rise to a level above the top of the aquifer

these deposits. However, it is likely that, given the close proximity of the site to the tidal Thames, the direction of groundwater movement would be with topography to the northwest, towards the River Thames in these shallow deposits.

Vol 16 Plate 13.4.1 Groundwater – contour map for the Chalk



**Extract from Vol 16 Figure 13.4.2*

13.4.14 Further detail on water level monitoring is provided in Vol 16 Appendix K.3.

Licensed abstractions

13.4.15 There are seven licensed groundwater abstractions (28/39/39/139, 28/39/42/33, 28/39/39/209, 28/39/39/141, 28/39/39/13, 28/39/42/0072 and TP07/005) from the lower aquifer located within 1km of the Albert Embankment Foreshore site; with three to the southwest, one to the west and east and two to the north. These abstraction sources are used for drinking water supply and for GSHP purposes. The locations of certain sources are shown in Vol 16 Figure 13.4.5 (see separate volume of figures).

13.4.16 The nearest licensed groundwater abstraction from the River Terrace Deposits or upper aquifer is located further than 1km from the site and therefore is unlikely to be impacted.

13.4.17 There are no known unlicensed groundwater abstractions from either the upper or lower aquifers locally.

Groundwater source protection zones

13.4.18 The Albert Embankment Foreshore site is located within the EA modelled Source Protection Zone 2 (SPZ 2) for a Thames Water Utilities source, which is in place in order to safeguard the groundwater resource from potentially polluting activities. The SPZ 2 is defined as the 400 day travel time from any point below the water table to the source.

13.4.19 The boundary of an EA modelled Source Protection Zone 1 (SPZ1), which has been derived to encompass three Chalk abstractions used for water supply purposes, is located 0.7km to the southwest of the Albert Embankment site.

Environmental designations

13.4.20 There are no other designations relevant to groundwater in the vicinity of the site.

Groundwater quality and land quality

13.4.21 Historical mapping reviewed as part of the land quality assessment identified no potentially contaminative onsite or nearby land uses (Vol 16 Section 8).

13.4.22 The groundwater quality assessment data obtained from ground investigation boreholes SR1078, SR1072A, PR1074, SR1074A, PR1085 and SA1082 (located within 1km of the Albert Embankment Foreshore site and shown in Vol 16 Figure 13.4.1, see separate volume of figures). The data has been compared with the UK drinking water standards (The Water Supply Regulations, 2000)[8] or relevant Environmental Quality Standards – EQS) (River Basin Districts Typology, Standards and Groundwater Threshold Values, 2010)[9].

13.4.23 The data shows exceedances with respect to heavy metals, pesticides and hydrocarbon contamination in the River Terrace Deposits, Thanet Sand and the Chalk. In particular, at a distance of approximately 0.5km from the site, are exceedances of nitrate in the Thanet Sand. Also at a distance of 0.9km from the site, are exceedances of polycyclic aromatic hydrocarbon (PAH) compounds in the Chalk. Further details can be found in Vol 16 Appendix K.7.

13.4.24 The land quality assessment data available for certain on-site monitoring boreholes listed above showed no exceedances of the human health screening values (soil guideline values designed to protect human health) within the River Terrace Deposits but exceedances with respect to heavy metals in the London Clay Formation and with respect to total petroleum hydrocarbons in the Laminated Beds (Lambeth Group). Further details are included in the land quality assessment (see Vol 16 Appendix F).

Groundwater flood risk

13.4.25 There is one reported incident of groundwater flooding in the vicinity of the site, based on information from the London Borough (LB) of Lambeth Strategic Flood Risk Assessment (SFRA) (Scott Wilson Ltd , 2009)[10]. The SFRA does not highlight groundwater flooding as a critical issue locally Therefore, no further analysis of this incident has been undertaken as part of the Level 2 SFRA].

Groundwater receptors

13.4.26 Groundwater receptors which could be affected during construction or operation are summarised in Vol 16 Table 13.4.3 below. It can be seen that the receptors of relevance to the Albert Embankment Foreshore site and which have therefore been assessed, are the Upper Aquifer, Lower Aquifer, Licensed Abstractions and planned developments.

Vol 16 Table 13.4.3 Groundwater – receptors

Receptor	Construction	Operation	Comment
Groundwater body – upper aquifer	✓	✓	Penetrated by CSO drop shaft, interception chamber & tunnel connecting these chambers
Groundwater body – lower aquifer	✓	✓	Base slab extends 0.6m into Upnor Formation
Licensed abstractions – lower aquifer	✓**	✗	Seven Chalk abstractions 28/39/39/139 28/39/39/141 28/39/42/033 28/39/39/013 28/39/39/209 28/39/42/007 TP07/005*
Licensed abstractions – upper aquifer	✗	✗	No upper aquifer licensed abstractions within 1km radius of site
Unlicensed abstractions	✗	✗	No known abstractions
Planned developments	✓**	✗	One planned Chalk GSHP licensed abstraction

** Consent number as no licence number issued yet*

*** Abstractions (licensed) would only be affected by construction phase, due to dewatering.*
Symbols ✓ applies ✗ does not apply

Receptor sensitivity

13.4.27 The upper aquifer is classified by the EA as a secondary A aquifer and is allocated a medium value in terms of both quantity and quality in this assessment.

13.4.28 The lower aquifer is a principal aquifer as classified by the EA, and hence is categorised as being of high value with regard to resources. Although the baseline groundwater quality data indicates the presence of certain contaminants, such as PAH, which could compromise the quality, for this assessment the lower aquifer is categorised as being of high value with regard to quality.

13.4.29 The sensitivity of individual abstraction licences has been assessed depending on their use, for example, a higher value is given to sources used for drinking water than for industrial purposes, which in turn are given a higher value than for amenity purposes. Also larger public water supply abstractions are given a higher value than generally smaller domestic supplies.

13.4.30 A summary of the value and sensitivity of relevant receptors is given in Vol 16 Table 13.4.4 below.

Vol 16 Table 13.4.4 Groundwater – resources value/ sensitivity

Receptor	Value/sensitivity
Groundwater quality	
Upper aquifer	Medium value; secondary A aquifer.
Lower aquifer	High value; principal aquifer.
Groundwater quantity (resources)	
Upper aquifer	Medium value; secondary A aquifer.
Lower aquifer (quality)	High value; principal aquifer.
Licensed Chalk abstraction 28/39/39/13, 28/39/39/139, 28/39/42/33, 28/39/42/007, TP07/005	High value, large GSHP in Chalk.
Licensed Chalk abstraction 28/39/39/141, 28/39/39/209	High value, drinking supply water from Chalk.

Construction base case

13.4.31 The construction base case in Site Year 1 is as per the current baseline and also includes any developments that are likely to be complete and partially or fully operational during construction at the Albert Embankment Foreshore site, and would have the potential to lead to a change to groundwater in the upper and lower aquifers.

13.4.32 The basements and underground structures associated with other developments identified in Vol 16 Table 13.3.1 could cause some disruption to groundwater flow in the upper aquifer. Any substantive changes from the baseline conditions prior to construction would be detected by monitoring of groundwater levels in the upper aquifer. Any potential SuDS scheme at Embassy Gardens is unlikely to impact on groundwater levels in the upper aquifer as it is not located immediately up or down-gradient of the Albert Embankment Foreshore site.

13.4.33 The base case in Site Year 1 of construction at the Thames Tideway Tunnel project site would include one planned abstraction for GSHP in the lower aquifer, at the Effra Site, as identified in Vol 16 Table 13.3.1, as this is likely to be active at the time of construction.

Operational base case

13.4.34 The operational base case is as per the construction base case. Therefore it can be concluded that there would be no change to the base case on Year 1 of operation in terms of groundwater flow in both the upper and lower aquifers.

13.5 Construction effects assessment

Construction impacts

Dewatering of aquifers

13.5.1 For the construction of the Thames Tideway Tunnel project as a whole, groundwater levels would have to be lowered by dewatering to allow construction of main tunnel shafts, CSO drop shafts, connection culverts and interception chambers. The impact of this dewatering from a nearby Kirtling Street main tunnel site is discussed in detail in Vol 3 Section 9. Impacts have been quantified by modelling (see Vol 3 Section 9 Appendix K.2) and the effects, where they are of relevance to the Albert Embankment Foreshore site, are included in this assessment.

13.5.2 In order to construct the CSO drop shaft and connection tunnel at Albert Embankment Foreshore, depressurisation in the Lambeth Group would be required. The lower part of the Lambeth Group is known to be in hydraulic connection with the lower aquifer (Upnor Formation, Thanet Sands and Chalk) (see para. 13.4.7). Depressurisation of the Lambeth Group would be achieved by abstracting water from the Chalk (dewatering) outside the diaphragm wall as described in Section 13.2. An estimate of the average amount of dewatering which would be needed at Albert Embankment Foreshore is less than 200m^3/d. This figure is low due to the close proximity of the Kirtling Street main tunnel site where average dewatering volumes would be much larger at approximately 440m^3/d.

13.5.3 Dewatering at nearby main tunnel site, in addition to the limited dewatering at the Albert Embankment Foreshore CSO drop shaft site contribute to the lowering of groundwater levels to a required level of drawdown. The full details of the effects on licensees in the vicinity of Albert Embankment Foreshore site are set out in the modelling report (see Vol 3 Appendix K.2). For each licensee the impact of drawdown is assessed by comparing it to the maximum available drawdown[xvii] at the licensee's borehole(s):

a. In the case of licence number 28/39/39/141 (Mantilla Limited), there are a number of boreholes at Dolphin Square. Modelling has predicted a drawdown of around 7.6m, this less than the maximum available drawdown of 9m. The modelled drawdown has predicted that water levels would stay at least 1. 4m above the pump. The magnitude of impact is assessed to be low.

b. In the case of licence number 28/39/42/0072 includes a public water supply borehole (Thames Water) at Battersea Pumping Station. Modelling has predicted a drawdown of around 8.6m, this less than the maximum available drawdown of 9.7m. The modelled drawdown has predicted that water levels would stay at least 1.1m above the pump. The magnitude of impact is assessed to be low.

c. In the case of licence number 28/39/39/139, there are two boreholes. Modelling has predicted a drawdown of 6.4m, this less than the maximum available drawdown of 18m. The magnitude of impact is assessed to be negligible.

d. In the case of licence number 28/39/42/033 this borehole has a predicted drawdown of 4.3m. The maximum available drawdown is 20m, therefore the magnitude of impact is assessed to benegligible.

e. In the case of licence number 28/39/39/13, this borehole has a predicted drawdown of 5.4m. The maximum available drawdown is 35m, therefore the magnitude of impact is assessed to be negligible.

f. In the case of licence number 28/39/39/209, this borehole has a predicted a drawdown of 5.8m. The maximum available drawdown of 25m, therefore the magnitude of impact is assessed to be negligible.

g. In the case of licence number 28/39/42/007, this borehole has a predicted drawdown of 6.25m. The maximum available drawdown is 30m, therefore the magnitude of impact is assessed to be negligible.

h. Consent number TP07/005 0.7km to east abstracts from Chalk for GSHP and is unlikely to be affected due to the distance and location up hydraulic gradient from the site.

Groundwater quality

13.5.4 The baseline groundwater quality data from nearby ground investigation boreholes shows exceedances in the River Terrace Deposits, Thanet Sand and the Chalk. The exceedances of polycyclic aromatic hydrocarbons (PAHs) are in the lower aquifer and at approximately 0.9km from the Albert Embankment Foreshore site. The only exceedance from the upper aquifer (River Terrace Deposits) is for nitrate. A diaphragm wall installed to form the CSO drop shaft would extend through the upper

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[xvii] Maximum available drawdown – is defined as the difference between the pumped water level and depth of the pump or difference between the pumped water level and the top of the Thanet Sand (which is designed to prevent oxidation and the mobilisation of natural pollutants); whichever is least of these two values is applied with this assessment.

aquifer and into the London Clay Formation. The diaphragm wall would contain an effective seal with the surrounding ground, thereby ensuring no pathway for groundwater contamination to occur. Therefore the magnitude of the impact on the upper aquifer is assessed to be negligible.

13.5.5 The main contamination identified locally lies within the lower aquifer. The presence of tight seal between the diaphragm wall and the ground will ensure that no additional pathways for ground movement. In addition, there will be limited dewatering at Albert Embankment Foreshore site (see para. 13.5.2). There is unlikely to be any deterioration in groundwater quality resulting from the construction methods being used at the Albert Embankment Foreshore site, where dewatering would be less than $200m^3/d$. Therefore any change in hydraulic gradients and groundwater flow velocities is anticipated to be small (from 177 to 185 m/year). . The magnitude of impact on the lower aquifer from this site would be negligible. Further discussion of the project-dewatering is included in para. 13.5.8

13.5.6 The EA aims to manage groundwater abstractions to keep groundwater levels above the top of the Thanet Sands. The lowering of water levels below the top of the Thanet Sands may lead to deterioration in water quality within the lower aquifer. The project-wide dewatering within the lower aquifer, and the limited dewatering at Albert Embankment site, would draw water levels down by an estimated 5m and this level of drawdown during construction is not anticipated to result in the water level dropping below the top of the Thanet Sands. The magnitude of the impact from dropping water levels down below the top of the Thanet Sand and into the lower aquifer is assessed to be negligible.

13.5.7 The grouting, if necessary would be in the Lower Mottled Beds of the Lambeth Group. The amount of treatment would depend on the depth of diaphragm wall and the ground conditions encountered. There is the potential for grout contaminated groundwater (characterised by excess turbidity) to migrate and impact on groundwater quality in the lower aquifer (Upnor Formation). Grout setting generally occurs on a timescale of a few minutes and therefore in most circumstances the impact is likely to be localised. The magnitude of the impact on the lower aquifer is assessed to be negligible.

13.5.8 The potential for movement of contamination at Albert Embankment Foreshore by project-wide dewatering, principally from Kirtling Street is discussed in Vol 3 Section10. It is unlikely that a quantitative risk assessment would be required for the site as the dewatering would be small and would be taken mainly from the Lambeth Group.

Physical obstruction

13.5.9 The presence of the diaphragm wall used to build the CSO drop shaft may disrupt groundwater flow and alter groundwater levels within the upper aquifer.

13.5.10 The method for assessing the impact of all below ground activities upon the groundwater levels in the upper aquifer is described in Vol 2 Appendix K.1. It is estimated that the groundwater level would rise during the construction phase at Albert Embankment Foreshore site by approximately 0.3m.

13.5.11 Groundwater levels in the upper aquifer are at about 99.8mATD, which is approximately 4.8m below the existing ground surface at Albert Embankment Foreshore site of 104.6mATD (see Vol 16 Table 13.4.1) . Therefore the small predicted rise in water levels (0.3m) on the southeast (upstream) side of the Albert Embankment Foreshore site would result in a negligible magnitude of impact on the upper aquifer.

13.5.12 The CSO drop shaft would extend down approximately 0.6m (from the top of the Upnor Formation) into the lower aquifer. The nearest abstraction point in the direction of groundwater flow is 0.6km away and the resulting impact would be minimal. The impact on this source is assessed as being negligible.

Construction effects

13.5.13 By combining the impacts above with the receptor value as shown in para. 13.4.26, the significance of the effects can be derived using the generic significance matrix (Vol 2 Section 2). The results are described in the following sections.

Dewatering of aquifers

13.5.14 A low impact has been assigned to two licensed abstractions, where the maximum predicted drawdown would not exceed the MAAD but would be within 20% of it. A low impact on high value receptors (28/39/39/0141 – Mantilla Limited - and 28/39/42/0072 – Thames Water Utilities Limited) would result in a **moderate adverse** effect for the period during which the predicted drawdown is within 20% of the MAAD (two and four months respectively). For the remainder of the construction period the effect on these receptors would be **minor adverse** (a negligible impact on a high value receptor).

13.5.15 In the case of other licences, which are also high value receptors, a negligible impact would result in a **minor adverse** effect on groundwater quantity in the lower aquifer.

Groundwater quality

13.5.16 Negligible impacts on groundwater quality within the upper aquifer, as a result of the potential movement of identified groundwater and soil contamination, on a medium value receptor for groundwater quality would result in an overall **negligible** effect.

13.5.17 Negligible impacts on groundwater quality in the lower aquifer have been identified as a result of the exceedances of PAH at a distance of 0.9km away. Movement is expected to be minimal as a result of construction which only extends 0.6m into the Upnor Formation and the small amounts of dewatering required at this site. A negligible impact on the lower aquifer, a high value receptor for groundwater quality would result in a **minor adverse** effect.

13.5.18 The project-wide dewatering would lower groundwater levels below the top of the Thanet Sands at this location. A negligible impact on the lower aquifer, on a high value receptor for groundwater quality would result in a **minor adverse** effect.

13.5.19 A negligible impact on groundwater quality in the lower aquifer has been identified as a result of grouting of the Lower Mottled Beds in the Lambeth Group for the construction of the CSO drop shaft. A negligible impact on a high value receptor would result in a **minor adverse** effect.

13.5.20 The potential for movement of contamination at Albert Embankment Foreshore site by project-wide dewatering is discussed in Vol 3 Section 9.

Physical obstruction

13.5.21 The physical impact of all below ground activities upon the local groundwater levels which is likely to result in a 0.3m rise is considered negligible. A negligible impact on a medium value receptor (upper aquifer) for groundwater quantity would result in a **negligible** effect.

13.5.22 The physical impact of the CSO drop shaft upon the lower aquifer can be considered negligible as the shaft would extend only 0.6m into the lower aquifer. A negligible impact on a high value receptor (lower aquifer) for groundwater quantity, would result in a **minor adverse** effect.

13.6 Operational effects assessment

Operational impacts

Physical obstruction

13.6.1 The presence of the operational CSO drop shaft, interception chamber and connection culvert in the upper aquifer may disrupt groundwater flow and alter groundwater levels.

13.6.2 The methodology for assessing the impact upon the groundwater levels in the upper aquifer is described in Vol 2 Appendix K.2. It is estimated that the groundwater level rise during the operational phase at Albert Embankment Foreshore site would be less than <0.1m.

13.6.3 Groundwater levels in the upper aquifer can reach 99.8mATD, this is approximately 4.8m below the existing ground surface at Albert Embankment Foreshore site. Given the small predicted rise in water levels (<0.1m) on the southeast (upstream) side of the structure, the magnitude of this impact on the upper aquifer is assessed as negligible.

13.6.4 The CSO drop shaft would extend down approximately 0.6m (from the top of the Upnor Formation) into the lower aquifer and with an external diameter of approximately 19m; this may form a physical obstruction to groundwater flow around the CSO site. The nearest abstraction point in the direction of groundwater flow is 0.6km away and the resulting physical obstruction would be minimal. The impact on this source is assessed as being negligible.

Seepage into CSO drop shaft

13.6.5 An estimate of the theoretical seepage volumes into the drop shaft at Albert Embankment Foreshore site is included in Vol 2 Appendix K.3. The estimated loss of water from the upper aquifer into the shaft is

73m^3/annum (Table K.4) and is assessed as negligible for the upper aquifer.

13.6.6 The estimated loss of water from the lower aquifer is 6m^3/annum which is considered to be a negligible impact.

Seepage from CSO drop shaft

13.6.7 An estimate of the theoretical seepage volumes from the drop shaft at Albert Embankment Foreshore site is included in Vol 2 Appendix K.3 The shaft would be full for only approximately 3% of the year or 11 days per year (see Vol 3 Section 9). The estimated volume of seepage from the drop shaft into the upper aquifer is 2m^3/annum (Table K.5). In addition, higher heads outside the drop shaft means that any risk of seepage from the drop shaft into the upper aquifer would be further reduced. The magnitude of impact has been assessed as negligible for the upper aquifer.

13.6.8 The estimated volume of seepage from the drop shaft into the lower aquifer is 0.25m^3/annum (Table K.5). The magnitude of impact has been assessed as negligible for the lower aquifer.

13.6.9 No other operational impacts are envisaged.

Operational effects

13.6.10 Combining the receptor value (para. 13.4.26) with the impacts identified above, the significance of the effects can be derived using the generic significance matrix (Vol 2 Section 2). The results are shown in the following sections.

Physical obstruction

13.6.11 The anticipated rise in upper aquifer water levels on the southeast side of the CSO drop shaft is less than 0.1m, and is considered to be negligible. A negligible impact on a medium value receptor, the upper aquifer, for groundwater quantity would lead to a **negligible** effect.

13.6.12 The physical obstruction impact on the lower aquifer is assessed as being negligible as the shaft would extend only a short distance (0. 6m) in the lower aquifer. The value of the lower aquifer is high with regards to groundwater quantity, would lead to a **minor adverse** effect

Seepage into CSO drop shaft

13.6.13 Seepage into the drop shaft has been determined as a negligible impact, which on a medium value aquifer (the upper aquifer) for groundwater quantity, would lead to a **negligible** effect. The same impact on a high value receptor (the lower aquifer) for groundwater quantity, would lead to a **minor adverse** effect.

Seepage from CSO drop shaft

13.6.14 Seepage from the drop shaft has been determined as a negligible impact, which on a medium value receptor (the upper aquifer) for groundwater quality, would lead to a **negligible** effect. The same impact on a high value receptor (lower aquifer) for groundwater quality, would lead to a **minor adverse** effect.

13.7 Cumulative effects assessment

Construction effects

13.7.1 Six developments have been identified in Vol 16 Table 13.3.1 which could potentially give rise to cumulative effects during construction relevant to groundwater in the upper aquifer through the inclusion of basements and SuDS. It is considered that although there may be local impacts on groundwater levels in the upper aquifer due to the vicinity of the developments, these impacts are not expected to be significant. Any substantive changes would be detected by monitoring of groundwater levels in the upper aquifer.

13.7.2 Neither of the developments would impact on the lower aquifer and therefore there would be no cumulative effects in the lower aquifer during the construction phase of the Albert Embankment Foreshore site.

Operational effects

13.7.3 One development has been identified in Vol 16 Table 13.3.2 to be under construction during the operation phase which could potentially give rise to cumulative effects relevant to groundwater in the upper aquifer through a basement. The development is located 0.9km southwest of the Thames Tideway Tunnel project site and therefore it is deemed that any changes in groundwater levels in the upper aquifer would not impact cumulatively during the operation phase.

13.7.4 The development would not impact on the lower aquifer and therefore there would be no cumulative effects on the lower aquifer.

13.8 Mitigation

13.8.1 The following section sets out further mitigation measures to be taken to address the significant effects identified within the assessment.

13.8.2 The main effects identified are from dewatering of lower aquifer during construction and the potential impacts on licensed abstractors.

Mitigation of construction effects

13.8.3 To mitigate the moderate adverse effects on the licensed abstractions (28/39/39/141 – Mantilla Limited and 28/39/42/72 – Thames Water Utilities Ltd, both of high value). The mitigation for these sources could comprise lowering pumps, deepening boreholes or, in the case of 28/39/39/141 provision of an alternative supply. These options will be discussed with the licence holder and mitigation measures agreed. In the case of 28/39/42/72, this source is one of several sources operated by Thames Water and the flexibility within its supply network may mean that another source could be used for a short period, rather than provision of new supply. Internal dewatering and increased ground treatment could be used to further limit the amount of dewatering required, which would reduce the volume of water removed at the Albert Embankment Foreshore site.

13.8.4 The groundwater monitoring strategy (see CoCP as mentioned in para. 13.2.4) is part of the overall project-wide mitigation. A comprehensive network of monitoring boreholes has been installed in both the upper and lower aquifers. The ongoing monitoring of groundwater levels and groundwater quality will detect any substantive changes from the baseline conditions during both the construction and operational phases.

13.9 Residual effects assessment

Construction effects

13.9.1 The measures proposed to mitigate the effects on licensed abstractors would have the effect of reducing the residual construction effects from moderate adverse to minor adverse effects. All residual effects are presented in Section 13.10.

Operational effects

13.9.2 As no mitigation measures are proposed, the residual operational effects remain as described in Section 13.6. All residual effects are presented in Section 13.10.

13.10 Assessment summary

Vol 16 Table 13.10.1 Groundwater – construction assessment summary

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Lower aquifer (licensed Chalk abstractions)	Lowering of groundwater levels in the Chalk resulting from dewatering	28/39/39/139 – Minor adverse 28/39/42/33 – Minor adverse 28/39/39/209 – Minor adverse 28/39/39/13 – Minor adverse 28/39/42/007 – Minor adverse TP07/005 – Minor adverse	None	Minor adverse
Lower aquifer (licensed Chalk abstractions)	Lowering of groundwater levels in the Chalk resulting from dewatering	28/39/39/141 – Moderate adverse (two months) 28/39/42/0072 – Moderate adverse (four months)	lowering of pump with modified pumping regime, provision of alternative supply (in the case of 28/39/39/141) or use of alternative public water supply source (in the case of 28/39/42/72) Use of	Minor adverse

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
			internal dewatering	
Lower aquifer (groundwater quality)	Deterioration in groundwater quality from groundwater mixing	Minor adverse	None	Minor adverse
	Deterioration in groundwater quality caused by creation of a pathway	Minor adverse	None	Minor adverse
	Deterioration in water quality in the Chalk from grouting	Minor adverse	None	Minor adverse
Upper aquifer	Deterioration in groundwater quality caused by creation of a pathway	Negligible	None	Negligible
Upper aquifer	Change in groundwater storage and flood risk as a result of physical obstruction in upper aquifer	Negligible	None	Negligible
Lower aquifer	Change in groundwater storage and flood risk as a result of physical obstruction in lower aquifer	Minor adverse	None	Minor adverse

Vol 16 Table 13.10.2 Groundwater – operational assessment summary

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Upper aquifer	Change in groundwater levels as a result of physical obstruction	Negligible	None	Negligible
Lower aquifer	Change in groundwater levels as a result of physical obstruction	Minor adverse	None	Minor adverse
Upper aquifer	Seepage into drop shaft affecting groundwater resources	Negligible	None	Negligible
Lower aquifer	Seepage into drop shaft affecting groundwater resources	Minor adverse	None	Minor adverse
Upper aquifer	Deterioration in water quality in the upper aquifer from seepage out of drop shaft	Negligible	None	Negligible
Lower aquifer	Deterioration in water quality in the lower aquifer from seepage out of drop shaft	Minor adverse	None	Minor adverse

References

[1] Defra. *National Policy Statement for Waste Water* (2012)

[2] Environment Agency*. Introducing pollution prevention: PPG 1 – EA Consultation* (2011).

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[4] Environment Agency. *Groundwater level contours for the Chalk aquifer* (2011b).

[5] British Geological Survey. British geology onshore digital maps 1:50 000 scale. Received from Thames Tunnel, (February 2009).

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.16**

Volume 16: Albert Embankment Foreshore site assessment

Section 14: Water resources - surface water

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Creating a cleaner, healthier River Thames

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Thames Tideway Tunnel

Environmental Statement

Volume 16: Albert Embankment Foreshore site assessment

Section 14: Water resources – surface water

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14 Water resources – surface water

14.1 Introduction

14.1.1 This section presents the findings of the assessment of the likely significant effects of the proposed development on surface water at the Albert Embankment Foreshore site. The assessment of surface water presented in this section has considered the requirements of the *National Policy Statement for Waste Water*, 2012 (NPS)[1]. The physical characteristics of the surface water environment including surface water resources and quality are presented and the anticipated effects (including cumulative effects) on these resources addressed in the assessment that follows. Further details on how the NPS requirements relevant to surface water resources have been met can be found in Volume 2 Environmental assessment methodology Section 14.3.

14.1.2 The proposed development has the potential to affect surface water resources (ie, surface waterbodies including the tidal reaches of the River Thames [tidal Thames]) due to:

a. construction activities

b. operation of the main tunnel.

14.1.3 The assessment of construction and operational effects on surface water includes the following:

a. identification existing surface water resources baseline conditions

b. determining base case conditions against which the proposed development has been assessed

c. assessment of significant beneficial from the proposed development during construction and operation and assesses the significance of the effects

d. identification measures and the residual effects both during construction and operation.

14.1.4 Two access options have been considered: Option A is via Lack's Dock and Option B involves the construction of a temporary road access between Camelford House and Tintagel House. Both options involve routes above the high water mark and the two routes would have the same impact/effect on surface water resources. The options are therefore not presented or reported separately for this topic.

14.1.5 The assessment of surface water effects partially overlaps with that for groundwater, land quality, aquatic ecology and flood risk. Effects on groundwater resources are assessed separately in Section 13 of this volume. Land quality is addressed in Section 8. Effects on aquatic ecology are assessed in Section 5. A Flood Risk Assessment (FRA), which assesses the effects of the proposed development on surface water run-off and considers the use of Sustainable Drainage Systems (SuDS), has been carried out separately and is included in Section 15 of this volume.

14.1.6 This assessment covers the effects of the proposed development at the Albert Embankment Foreshore site and in particular in relation to the interception of Clapham Storm Relief and Brixton Storm Relief combined sewer overflows (CSOs). It is however important to recognise that whilst the reductions in spills from the Clapham Storm Relief and Brixton Storm Relief CSOs would be important to water quality in the immediate area of the CSO outfalls, the overall water quality benefits in any part of the tidal Thames would accrue as a result of the project as a whole, rather than a single part of it. The catchment-wide effects on the tidal Thames, particularly in relation to the water quality improvements anticipated from the proposed Thames Tideway Tunnel project are assessed separately and presented in Volume 3 Project-wide effects assessment.

14.1.7 Plans of the proposed development as well as figures included in the assessment for this site are contained in a separate volume (Volume 16 Albert Embankment Foreshore Figures).

14.2 Proposed development relevant to surface water

14.2.1 The proposed development is described in Section 3 of this volume. The elements of the proposed development relevant to surface water are set out below.

Construction

14.2.2 The Albert Embankment Foreshore site is partly located within the River Thames channel, which means that some of the proposed working area would be within the river bed. A temporary cofferdam would be constructed in the foreshore to enable construction of the permanent works site (see Construction plans, separate volume of figures – Section 1).

14.2.3 Barges would be used to import the majority of the cofferdam fill, although it is assumed that other imported materials would be brought in by road. Barges would also be used to export the majority of the cofferdam fill and excavated material from the CSO drop shaft and other structures. In order to facilitate the use of barges, campsheds would be constructed adjacent to the working area.

14.2.4 A connection culvert between the Brixton Storm Relief CSO and Clapham Storm Relief CSO would be constructed to link the two. A CSO drop shaft would be constructed at the site. Based on the geology at the site, no dewatering of the upper aquifer would be required, although dewatering of the Lambeth Group may be required. Disposal of dewatering effluent can have an impact on surface water. See Section 13 of this volume for further details on the dewatering requirements.

14.2.5 Five steel monopile dolphins (in-river structures) would be constructed to upstream of the permanent structure to protect against impacts from river vessels.

14.2.6 The construction of in-river structures and in particular the temporary works cofferdams would affect the river regime with the potential that localised increases in flow velocity cause scour of the river bed and foreshore, or deposition of sediments. The scour could occur around the face of the cofferdam or at the adjacent bridge supports (abutment scour) or across the channel width (contraction scour). Any potential scour development during construction would be monitored and if relevant trigger levels are reached, appropriate protection measures would be provided. Further details are provided in *Scour and Accretion Monitoring and Mitigation Plan for Temporary Works in the Foreshore* (Vol 3 Appendix L.4).

Code of Construction Practice

14.2.7 There is a direct pathway for pollutants to be discharged to the tidal Thames due to the location of part of the construction area within the river channel. The *Code of Construction Practice (CoCP)*[i] Part A (Section 8) including such as discharge of pollutants via surface water drains and these are summarised below.

14.2.8 Appropriate drainage, sediment and pollution control measures are included in the *CoCP* Part A (Section 8). These are in accordance with the relevant *Pollution Prevention Guidelines* (*PPGs*) issued by the Environment Agency (EA) and other Construction Industry Research and Information Association (CIRIA) documents.

14.2.9 All site drainage would be drained and discharged to mains foul or combined sewers. Where this is not practicable, the site would be drained such that accumulating surface water would be directed to holding or settling tanks, separators and other measures prior to discharge to surface water drains. Foul drainage from the site welfare facilities would be connected to the mains foul or combined sewer.

14.2.10 Suitable spill kits would be provided and positioned in vulnerable areas, staff would be trained in their use and a record would be kept of all pollution incidents or near-misses, to ensure appropriate action is taken and lessons are learned from any incidents. Regular ‘toolbox talks’ would be held to raise staff awareness of pollution prevention and share lessons learned from any recorded incidents. There would be written procedures in place for dealing with spillages and pollution (the *Pollution Incident Control Plan* or *PICP*).

14.2.11 The *CoCP* Part B (Section 8) incorporates one measure relevant to the surface water assessment. The area of foreshore between working sites would be monitored for spillage of oils, fuels and other materials during use. The Contractors Environmental Management Plan (CEMP) would include specific control and mitigation measures at this location.

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[i] *CoCP* is provided in Vol 1 Appendix A. It contains general requirements (Part A), and site specific requirements for this site (Part B).

Operation

14.2.12 The operation of the main tunnel would enable the interception of combined sewage generated during storms which would otherwise discharge to the tidal Thames at the Albert Embankment Foreshore from the Clapham Storm Relief and Brixton Storm Relief CSOs. There would therefore be a reduction in the frequency, duration and volume of spills from these CSOs.

14.2.13 The construction of the new permanent structure in the river would affect the river regime with the potential that localised increases in flow velocity cause scour of the river bed and foreshore, or deposition of sediments. Scour protection for the new permanent works would be provided and this would be located within the parameter plan for the site. The approach to scour on third party structures, contraction scour and accretion during the operational phase would be a reactive approach with mitigation measures only provided if required. Further details of the approach are provided in the *Engineering Design Statement*.

14.3 Assessment methodology

14.3.1 The methodology used for the assessment of effects on surface water differs from the standard Website Transport Analysis Guidance (WebTAG) (DFT, 2003)[2] environmental impact assessment (EIA) methodology for water resources, in that the requirements of the Water Framework Directive (WFD) have also been taken into account. In the absence of an EIA specific assessment methodology for WFD compliance, an assessment methodology has been derived specifically for the Thames Tideway Tunnel project to assess significance of effects. The methodology also takes into consideration the requirements of the Urban Waste Water Treatment Directive (UWWTD)[3] and is outlined in Vol 2 Section 14. A WFD assessment for the project as a whole is presented in Vol 3 Section 14.

Engagement

14.3.2 Vol 2 documents the overall engagement which has been undertaken in preparing the *Environmental Statement*. Vol 2 Section 14 summarises the engagement that has been undertaken for the surface water assessment and the consultation responses relevant to surface water.

14.3.3 There are no site-specific engagement comments relevant to the surface water assessment at Albert Embankment Foreshore.

Baseline

14.3.4 The baseline methodology follows the methodology described in Vol 2 Section 14. There are no site-specific variations for identifying baseline conditions for this site.

Construction

14.3.5 The assessment methodology for the construction phase follows that described in Vol 2 Section 14. There are no site-specific variations for undertaking the construction assessment of this site.

14.3.6 The assessment year for construction effects is Site Year 1 (2017) when construction would commence. No modelled water quality data are available for this year. The water quality conditions for the base case have therefore been derived from available modelled simulation data which uses population projections for 2021. This assumption is considered reasonable as substantial changes in water quality are considered unlikely between 2017 and 2021.

14.3.7 The Lee Tunnel and the sewage works upgrades at Mogden, Beckton, Crossness, Long Reach and Riverside sewage treatment works (STWs) would be operational by the time construction of the Thames Tideway Tunnel project commences, as described in Vol 2 Section 14. Significant improvements in the water quality in the tidal Thames are anticipated as a result of these projects. Both the construction base case and the operational base case would be the water quality in the tidal Thames with the Lee Tunnel and sewage works upgrades in place.

14.3.8 The construction base case has considered the developments that are scheduled to be complete and in operation by Site Year 1 (presented in Vol 16 Appendix N). The developments in Vol 16 Appendix N would not result in additional surface water receptors (ie, waterbodies and are considered unlikely to result in changes in water quality as the majority are remote from the tidal Thames. The base case would therefore not change from that outlined above.

14.3.9 The phases of the developments that would be under construction during Site Year 1 have been considered in the cumulative effects assessment (see Section 14.7).

14.3.10 The assessment area for the assessment of effects of construction activities at Albert Embankment Foreshore site would be limited to two sections of the river, namely the Thames Upper and Middle waterbodies listed below in Vol 16 Table 14.4.1.

14.3.11 Section 14.5 details the likely significant effects arising from the construction at the Albert Embankment Foreshore site. There are no other Thames Tideway Tunnel project sites which could give rise to additional effects on surface water within the assessment area for this site, therefore no other Thames Tideway Tunnel project sites are considered in this assessment

Operation

14.3.12 The assessment methodology for the operation phase follows that described in Vol 2 Section 14. There are no site-specific variations for undertaking the operational assessment of this site.

14.3.13 The assessment year for operation effects is Year 1 of operation. As with the construction assessment, the operational assessment also relies on modelled water quality data which uses population projections for 2021. In addition, the influence of climate change on the proposed development has been assessed in 2080.

14.3.14 As noted above, the operational base case would be the water quality in the tidal Thames with the Lee Tunnel and sewage works upgrades in place. The operational base case has considered the developments that are scheduled to be complete and in operation by Year 1 of operation (presented in Vol 16 Appendix N). The developments in Vol 16 Appendix N would not result in additional surface water receptors and are considered unlikely to result in changes in water quality as the majority are remote from the tidal Thames. The base case would therefore not change from that outlined above.

14.3.15 The phases of the developments that would be under construction during Year 1 of operation have been considered in the cumulative effects assessment (see Section 14.9).

14.3.16 The operational assessment uses the same assessment area identified above for the construction assessment.

14.3.17 Section 14.6 details the likely significant effects arising from the operation at the Albert Embankment Foreshore site.

Assumptions and limitations

14.3.18 The assumptions and limitations associated with this assessment are presented in Vol 2 Section 14. . Based on the geology at the site, it is assumed some dewatering of the Lambeth Group may be required. There are no other assumptions and limitations specific to the assessment of this site.

14.4 Baseline conditions

14.4.1 The following section sets out the baseline conditions for surface water within and around the site. Future baseline conditions (base case) are also described.

Current baseline

Water quality

14.4.2 A list of all surface water receptors and their WFD status given in the *River Basin Management Plan (RBMP)* (EA, 2009)[4], which are either adjacent to the site or downstream of the site and therefore have the potential to be affected by the proposed development[ii], is included in Vol 16 Table 14.4.1 below.

14.4.3 The overall classification of status or potential under the WFD is a detailed process, which includes an assessment of water quality, physico-chemical

[ii] The EA has provided advice on CSO excursion areas[ii], which states that CSOs below Tower Bridge will only impact the Thames Middle waterbody and those upriver of Tower Bridge will impact both the Thames Upper and Thames Middle waterbodies.

and hydromorphological elements and mitigation measures to give an overall ecological status or potential. Reference should be made to the United Kingdom Technical Advisory Group (UKTAG)[5] guidance, as given in the *RBMP* (EA, 2009)[6].

Vol 16 Table 14.4.1 Surface water – receptors

Waterbody name/ID	Hydro-morphological status	Current ecological quality	Current chemical quality	2015 Predicted ecological quality	2015 Predicted chemical quality	2027 target status
Thames Upper GB530603911403	Heavily modified	Moderate potential	Good	Moderate potential	Good	Good
Thames Middle GB530603911402	Heavily modified	Moderate potential	Fail	Moderate potential	Fail	Good

14.4.4 The River Thames and its Tidal Tributaries are designated as a Site of Importance for Nature Conservation (Grade III of Metropolitan importance). The Thames Upper (which stretches from Teddington to Battersea Bridge) and the Thames Middle (which stretches from Battersea Bridge to Mucking Flats) waterbodies are considered to be high value waterbodies as although their current and predicted status in 2015 (target date from *RBMP* [EA, 2009][7]) is moderate potential; there is a status objective of good by 2027. In addition, the tidal Thames is a valuable resource and plays an important role as a water resource, habitat, and source of amenity, recreation, and transport route throughout London.

14.4.5 Sediment levels within the tidal Thames are estimated to currently reach a peak of 4,000kg/s in the lower Thames estuary, or more than 40,000t of sediment a day during spring tides (HR Wallingford, 2006)[8].

14.4.6 There are no licensed surface water abstractions within 1km of the Albert Embankment Foreshore site.

14.4.7 The Albert Embankment Foreshore site is less than 1km downstream of the EA's Cadogan Automatic Quality Monitoring Station (AQMS), as shown on Vol 16 Figure 14.4.1 (see separate volume of figures). 2011 summary data from the AQMS monitoring point, which gives monthly 90 percentile values for Ammonium (concentration that is exceeded 10% of the time) and 10% percentile values for dissolved oxygen (DO) (concentration exceeded 90% of the time), are presented below in Vol 16 Table 14.4.2.

Vol 16 Table 14.4.2 Surface water – Cadogan Pier AQMS 2011

Month	DO (mg/l) (10%)	Ammonium (mg/l) (90%)
January	11.06	4.15
February	9.18	0.57
March	8.44	0.84

Month	DO (mg/l) (10%)	Ammonium (mg/l) (90%)
April	5.89	1.54
May	6.15	1.84
June	3.7	1.68
July	3.17	1.90
August	3.04	3.06
September	4.34	4.04
October	5.60	6.24
November	5.22	4.80
December	8.09	4.41

14.4.8 The data presented above, demonstrate that the DO levels in the tidal Thames decrease in the summer months, as there is an inverse relationship between temperature and oxygen saturation ie, warmer water holds less DO than colder water. The discharge from the Clapham Storm Relief and Brixton Storm Relief CSOs has the effect of depleting DO in the tidal Thames as a result of the biological breakdown of organic matter in the discharges. This causes both a localised (at Albert Embankment Foreshore site) and a more widespread tidal Thames effect of rapidly dropping DO levels. Vol 3 Section 14 details half-tide plots displaying the changes in DO levels along the tidal Thames.

14.4.9 As the Albert Embankment Foreshore site lies at some distance from the Cadogan AQMS point (as shown on Vol 16 Figure 14.4.1, see separate volume of figures), the spot sampling results from London Bridge have also been considered. Vol 16 Table 14.4.3 shows the summary 90 percentile values for Ammonium (concentration that is exceeded 10% of the time) and 10% percentile values for DO (concentration exceeded 90% of the time) for spot sample results collected between 2005 and 2009.

Vol 16 Table 14.4.3 Surface water – London Bridge 2011 spot samples

EA spot sample site	DO (mg/l) (10%)	Ammonium (mg/l) (90%)
Thames at London Bridge	4.81	10.92

14.4.10 Classification of DO standards for transitional waters under the WFD is dependent on the salinity levels. The above 10 percentile values would place the Thames Middle waterbody within the good or moderate potential range, dependent on the associated salinity values.

14.4.11 Historical mapping has potentially contaminative industrial uses within a 250m search radius, which includes oil and gas works, wharves and a distillery. There is the potential for these to have impacted upon the proposed development. An assessment of potential on-site contamination is provided within Section 8 of this volume.

Current CSO operation

14.4.12 The current operation of the Clapham Storm Relief and Brixton Storm Relief CSO has been characterised using the catchment model of the sewer system (see Vol 3 Section 14 for further details of catchment modelling), and the annual average duration, frequency and volume of spill has been defined as follows:

14.4.13 For Brixton Storm Relief CSO:

a. the CSO spills on average 29 times in the Typical Year[iii]

b. the CSO spills for a total duration of 133 hours in the Typical Year

c. the spill volume from the CSO is approximately 265,000m^3 in the Typical Year, representing 0.7% of the total volume discharged to the tidal Thames in the Typical Year from all CSOs.

14.4.14 For Clapham Storm Relief CSO:

a. the CSO spills on average six times in the Typical Year

b. the CSO spills for a total duration of 14 hours in the Typical Year

c. the spill volume from the CSO is approximately 13,000m^3 in the Typical Year, representing 0.03% of the total volume discharged to the tidal Thames in the Typical Year from all CSOs.

14.4.15 Using the same model the annual polluting loading of biochemical oxygen demand (BOD), ammonia and total Kjeldahl nitrogen (TKN) (the sum of organic nitrogen, ammonia (NH_3), and ammonium [NH_4^+]) of spills has been defined as follows:

14.4.16 For Brixton Storm Relief CSO:

a. the CSO discharges 12,000kg of BOD in the Typical Year

b. the CSO discharges 360kg of ammonia in the Typical Year

c. the CSO discharges 2,200kg of TKN in the Typical Year.

14.4.17 For Clapham Storm Relief CSO:

a. the CSO discharges 250kg of BOD in the Typical Year

b. the CSO discharges 10kg of ammonia in the Typical Year

c. the CSO discharges 40kg of TKN in the Typical Year.

14.4.18 Each discharge increases the risk of exposure to pathogens for river users who come into contact with the water. An assessment of health impacts upon recreational users of the River Thames was conducted and reported by the Health Protection Agency in 2007 (Lane *et al.*, 2007)[9]. The study concluded that risk of infection can remain for two to four days following a

iii Typical Year: single year which is most representative of an observed typical year of rainfall with the dataset. The 1979-1980 'water year' defined as the 12 month period ending on the 30th September 1980 spill as the water containing the sewage moves back and forward with the tide[iv]. The same study also noted that analysis of the illness events reported against discharges on the tidal Thames shows that 77% of cases related to rowing activities undertaken within three days of a CSO spill.

14.4.19 Assuming the average 29 spills per annum occur from the Brixton Storm Relief CSO and six spills per annum from Clapham Storm Relief CSO on separate days, there could be up to a maximum of 140 days per year where recreational users are at risk of exposure to pathogens in the vicinity of the outfall as a result of the Brixton Storm Relief and Clapham Storm Relief CSO spills alone (Lane *et al.*, 2007)[10].

14.4.20 The operation of the Clapham Storm Relief and Brixton Storm Relief CSOs results in the discharge of sewage litter along with the discharge of effluent. It has been estimated by the *Thames Tunnel Strategic Study (TTSS)* that overflows from all the CSOs along the tidal Thames introduce approximately 10,000t of sewage derived solid material to the tidal Thames annually. Catchment modelling of the current CSO operation has defined the average volume of discharge from the Clapham Storm Relief and Brixton Storm Relief CSOs and assuming litter tonnages are proportional to discharge volumes, this would indicate that approximately 70t of sewage derived litter is discharged from the Clapham Storm Relief and Brixton Storm Relief CSOs combined in the Typical Year. An assessment of the amenity effects of the sewage litter is given in Vol 3 Section 10 Socio-economics.

Construction base case

14.4.21 As explained in Section 14.3, both the construction base case and the operational base case would be the water quality in the tidal Thames with the Lee Tunnel schemes and sewage works upgrades in place (further details are provided below under operational base case).

14.4.22 The base case in Site Year 1 of construction taking into account the schemes described in Section 14.3 would not change since no new sensitive receptors would be introduced.

Operational base case

14.4.23 As noted above, the operational base case would be the same as the construction base case and would include water quality improvement achieved by the Lee Tunnel and the sewage works upgrades.

14.4.24 The base case in Year 1 of operation taking into account the schemes described in Section 14.3 would not change since no new sensitive receptors would be introduced.

14.4.25 Catchment modelling results of the base case have demonstrated that by Year 1 of operation (assessed using 2021 to use modelled assumptions),

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[iv] The EA has provided advice on CSO excursion areas[iv], which states that CSOs below Tower Bridge will only impact the Thames Middle waterbody and those upriver of Tower Bridge will impact both the Thames Upper and Thames Middle waterbodies.

the frequency, duration and volume of spills from the Clapham Storm Relief and Brixton Storm Relief CSOs would have increased (as a result of increased population) beyond the current baseline as follows:

14.4.26 For Brixton Storm Relief CSO

a. the CSO would spill 31 times in the Typical Year (two more than the current baseline)

b. the CSO would spill for 141 hours in the Typical Year (eight hours more than the current baseline)

c. the spill volume from the CSO would be approximately 279,000m^3 in the Typical Year (14,000m^3 more than the current baseline).

14.4.27 For Clapham Storm Relief CSO:

a. the CSO would spill six times in the Typical Year (the same as the current baseline)

b. the CSO would spill for 15 hours in the Typical Year (one hour more than the current baseline)

c. the spill volume from the CSO would be approximately 14,000m^3 in the Typical Year (1,000m^3 more than the current baseline).

14.4.28 The same catchment modelling has demonstrated that by the operational assessment year, the annual polluting loading of BOD, ammonia and TKN would have increased (as a result of increased population) beyond the current baseline as follows:

14.4.29 For Brixton Storm Relief CSO:

a. the CSO would discharge 14,000kg of BOD in the Typical Year (2,000kg more than the current baseline)

b. the CSO would discharge 470kg of ammonia in the Typical Year (110kg more than the current baseline)

c. the CSO would discharge 2,200kg of TKN in the Typical Year (the same as the current baseline).

14.4.30 For Clapham Storm Relief CSO:

a. the CSO would discharge 370kg of BOD in the Typical Year (120kg more than the current baseline)

b. the CSO would discharge 10kg of ammonia in the Typical Year the same as the current baseline)

c. the CSO would discharge 60kg of TKN in the Typical Year (20kg more than the current baseline).

14.4.31 Following on from the interpretation of the current baseline as per para. 14.4.15 the number risk days for river users being exposed to pathogens during the operational base case year (taking into account be 2021 to use modelled assumptions) would be a maximum of 148 days in the Typical Year as a result of spills from the Clapham Storm Relief and Brixton Storm Relief CSOs alone.

14.4.32 Similarly, the tonnage of sewage derived litter discharged from the Clapham Storm Relief and Brixton Storm Relief CSOs can be expected to increase by approximately 5%, from approximately 70t to approximately 74t in the Typical Year.

14.5 Construction effects assessment

14.5.1 This section presents the construction impacts that could occur at the site and identifies where no further assessment of effects is required (eg, where the impact pathway has been removed). The second part of the section then identifies any effects that may occur and the likely significance of these effects.

Construction impacts

Temporary land take and morphological changes

14.5.2 In order to accommodate the temporary works at the Albert Embankment Foreshore site, construction of a temporary cofferdam within the river channel would be required as described in Section 3 of this volume. The channel would be more constricted than at present and together with the new profile of the structure, this would be likely to lead to changes in flows (velocities, directions) and lead to changes in scour and deposition of sediments.

Release of sediments from piling and scour

14.5.3 Minor amounts of sediment could be released during piling operations. The total volume of sediment released to the tidal Thames by the proposed pilling activity at all construction sites has been estimated to be 890t[v]. The proportion of this estimate that would originate from the Albert Embankment site is approximately 187t.

14.5.4 It is also possible that the temporary cofferdam would affect the river regime with the potential that localised increases in flow velocity cause scour of the river bed and foreshore and could result in the mobilisation of suspended solids. Any potential scour development during construction would be monitored and protection measures provided if set trigger levels are reached (see Vol 3 Appendix L.4).

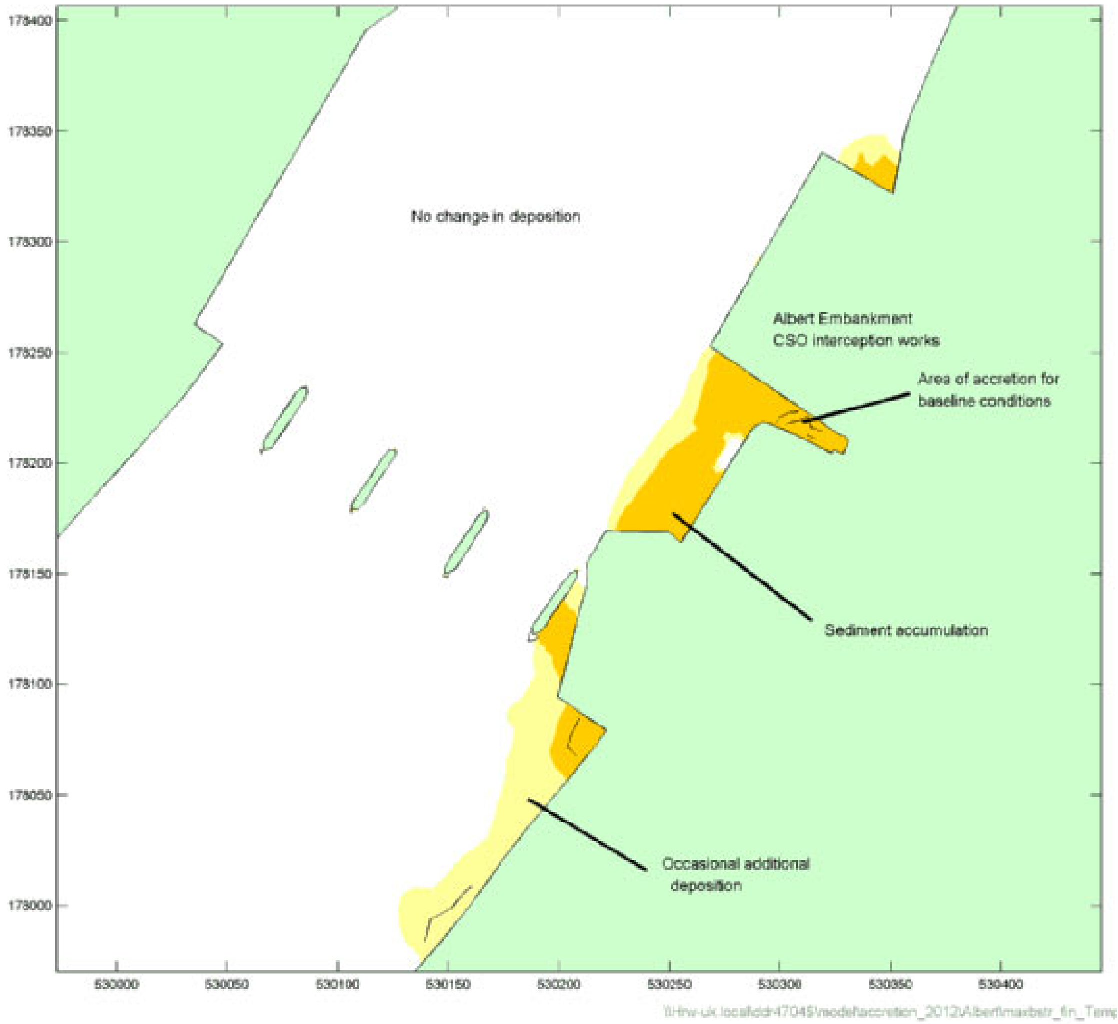
14.5.5 The tideway Thames is a high sediment environment and levels already present within the tidal Thames are estimated to reach a peak of 4,000kg/s in the lower Thames estuary or more than 40,000t of sediment passing the site four times a day during spring tides (HR Wallingford, 2006)[11]. In this context, the volumes produced by the construction works from piling, dredging or scour would not be detectable against natural fluctuations in sediments and would not have an impact on surface water resources (HR Wallingford, 2006)[12] and are therefore not considered further within the assessment.

[v] An assessment of the potential sediment losses anticipated from construction activities within the foreshore is provided in the *Habitats regulation assessment.*

Deposition

14.5.6 The temporary cofferdam would be likely to lead to changes in flows (velocities, directions) and cause changes in deposition of sediments around the Albert Embankment Foreshore site. These sediments could be those generated by the project itself but would also include sediments occurring naturally in the water column. Modelling carried out (Vol 3 Appendix L.3) has predicted the extent of this deposition, as shown below in Vol 16 Plate 14.5.1.

Vol 16 Plate 14.5.1 Surface water – prediction deposition around temporary works at the Albert Embankment foreshore site



14.5.7 Most deposition is likely to be localised and occur in newly created areas of slack water (as shown above in Vol 16 Plate 14.5.1) but may be remobilised by spring tides (for deposition during neap tides) or by large fluvial flows (for deposition during seasonal low fluvial flows). The overall impact on channel morphology would be negligible.

14.5.8 Impacts on channel morphology from deposition can have an effect on ecological receptors, by changing habitat availability. This effect is assessed in Section 5 of this volume.

Pumping and pollution during cofferdam construction

14.5.9 The main pathways for surface water quality impacts during construction at the Albert Embankment Foreshore site are as a result of the requirement for a cofferdam to be constructed in the river channel for both the main construction work and to house the permanent structures once construction is complete. The cofferdam would be constructed by driving sheet piles into the river bed, which would be sealed and the water pumped out into the river channel. As the works would be in the channel, there would be a direct pathway for pollutants to be discharged to the river during the construction of the cofferdam which could impact on water quality in this location of the tidal Thames. The adoption of appropriate drainage and pollution control measures as included in the *CoCP* Part A (Section 8) (see para. 14.2.7) should remove the impact pathway.

14.5.10 Before being released to the river, the water to be pumped from behind the cofferdam would be subject to settlement using a lagoon/pond, silt trap or other suitable method (see *CoCP* Part A (Section 8)) to ensure excessive levels of potentially contaminated suspended solids are not discharged to the tidal Thames. It is considered that via the proposed management of pumping out water from the cofferdam area, the pollution pathway is removed and therefore no impact is anticipated from this source and this is not considered further in the assessment.

Foreshore and contamination within the river channel

14.5.11 Intrusive ground contamination testing of foreshore sediments was carried out at the Albert Embankment Foreshore site, which identified a contamination risk from arsenic, zinc, copper and lead, where samples were all above the TEL. Given the current environment (ie, high water flow and sediment movement), it is expected that the majority of mobile contaminants have already been leached from the sediment, although the disturbance of sediments caused by the proposed construction works could cause additional sediment contamination to be leached.

14.5.12 Any additional sediments input to the river as a result of construction processes would be minimal in comparison to the already high background levels (see para. 14.4.5) and any mobilised contaminants would be expected to be rapidly diluted and their potential impact on water quality attenuated. Sediments mobilised by the construction works (including piling for the cofferdam walls) are therefore likely to pose only a low risk of causing deterioration in water quality. Such sediments are continually transported along the tidal Thames as a natural action of erosion and deposition, as well as by other dredging operations and river users and sediment loads within the river are already high.

14.5.13 Therefore, there is considered to be no impact from this source and this is not considered further within this assessment.

Surface water drainage

14.5.14 Once constructed, the cofferdam area and the shaft construction work within it would be protected from flooding to ensure the construction activity is not affected by high water levels. This would require the cofferdam walls to be built to the same height as the existing flood defence level. Surface water from rainfall on the CSO drop shaft construction area may need to be pumped periodically to ensure the working activities are not affected by ponding of rainwater, if drainage of surface water by gravity is not possible.

14.5.15 The construction of the working area and drainage of surface water from it could therefore create a direct pathway to the river for contaminated runoff, high suspended solids and other pollution from the site. However, appropriate site drainage would be used to control pollutants in the general site runoff, preventing the discharge of pollutants via combined or surface water drains as part of the surface water discharge from the construction site (see *CoCP* Part A (Section 8)). This would enable the pollution pathway to be removed and therefore there is considered to be no impact from this source. Surface water drainage is not considered further within this assessment.

Debris accumulation

14.5.16 The temporary cofferdam at the Albert embankment Foreshore site may interact with Chelsea Bridge to cause an area of slack 'dead' water between them. Floating debris, oils and other pollutants could build up in the area if the flow of the river is unable to clear the accumulation due to the shelter provided by the Albert Embankment Foreshore site working area.

Dewatering

14.5.17 Settlement of suspended solids within the dewatering from the Lambeth Group would minimise the levels of contaminants within the effluent, which tend to be associated with particulates.

14.5.18 Dewatering effluent would be subject to appropriate treatment and it is therefore considered that there is no pollution pathway and hence no impact from dewatering. This is therefore not considered further within the assessment.

Construction effects

14.5.19 The potential surface water impacts identified above as likely as a result of construction at Albert Embankment Foreshore site have been assessed for their likely effects on WFD objective compliance, compliance with other legislation and effects on other users of the surface waters. The surface water receptors are identified in Vol 16 Table 14.4.1.

14.5.20 The WFD objectives set out in Article 4 of the WFD are as follows:

a. WFD1 – Prevent deterioration of the status of all bodies of surface water.

b. WFD2 – Protect, enhance and restore all bodies of surface water, with the aim of achieving good surface water status by 2015.

c. WFD3 – Protect and enhance all artificial and heavily modified bodies of water, with the aim of achieving good ecological potential and good surface water chemical status by 2015.

d. WFD4 – Reduce pollution from priority substances and cease or phase out emissions, discharges and losses of priority hazardous substances.

14.5.21 The significance of these effects has then been assessed based on the magnitude of the impacts as described in Vol 2 Section 14.5.

Temporary land take and morphological changes

14.5.22 The presence of the construction cofferdam in the channel would impact on the morphology of the tidal Thames in this location, altering it from its current state.

14.5.23 At the end of the construction, part of the riverbed would be reinstated following the removal of the temporary structures. This is due to the natural circulation of sediments within the estuary, the accumulation of silts and estuarine mud that is likely to occur. The temporary change is also unlikely to alter the “in place” mitigation measures identified in the *RBMP* as necessary to achieve good ecological potential. Therefore, because mitigation measures required to meet the WFD objective of Good Ecological Potential could still be implemented irrespective of the proposed development at this site, works at this site would not prevent any of the WFD objectives being met in the future. However, there would be a measurable change in foreshore morphology during construction and hence the effect is considered to be **minor adverse**.

14.5.24 Impacts on channel morphology can have an effect on ecological receptors, by changing habitat availability. This effect is assessed in Section 5 of this volume.

Debris accumulation

14.5.25 The change in flow regime of the tidal Thames due to piling activities may result in an area of slack ‘dead’ water between the construction area and the adjacent Vauxhall Bridge, where floating debris, oils and other pollutants could build up and reduce the amenity value of the river for recreational users.

14.5.26 A change in appearance and aesthetic quality of the tidal Thames in the vicinity of the site is likely, but it would not prevent or limit recreational use of the tidal Thames in this location. There are no abstractions or discharges that could be affected by this change in debris accumulation, which would also not affect compliance with the WFD or other legislation as it is not assessed under this legislation. Therefore, the effect is considered to be **minor adverse**.

14.6 Operational effects assessment

14.6.1 This section presents the operational impacts that could occur at the site. The second part of the section identifies any effects that may occur and the likely significance of these effects.

Operational impacts

Reduction in Clapham Storm Relief and Brixton Storm Relief CSOs spills

14.6.2 Catchment modelling of the operational development case (with the operational Thames Tideway Tunnel project) predicts that by Year 1 of operation, the frequency, duration and volume of spills from the Clapham Storm Relief and Brixton Storm Relief CSOs would substantially decrease (as a result of the capture of CSOs into the main tunnel) as follows:

14.6.3 For Brixton Storm Relief CSO:

a. the CSO would spill on average once per year (30 times less than the operational base case)

b. the CSO would spill for an average duration of four hours (137 hours less than the operational base case)

c. the spill volume from the CSO would be approximately 5,700m^3 per year (273,300m^3 less than the operational base case).

14.6.4 For Clapham Storm Relief CSO

a. the CSO would spill on average once per year (five times less than the operational base case)

b. the CSO would spill for an average duration of five hours (ten hours less than the operational base case)

c. the spill volume from the CSO would be approximately 7,900m^3 per year (6,100m^3 less than the operational base case).

14.6.5 The frequency, duration and volume of spill at Albert Embankment Foreshore site would therefore be reduced by approximately 95% as a result of the operation of the Thames Tideway Tunnel project.

14.6.6 Given the reductions in spills, the number of days in which river users would be exposed to pathogens in Year 1 of operation as a result of spills from the Clapham Storm Relief and Brixton Storm Relief CSOs would be a maximum of eight days in the Typical Year (a reduction of up to 140 days of risk of exposure).

14.6.7 Similarly, the tonnage of sewage derived litter from the CSO can be expected to reduce by approximately 95%, from approximately 74t to approximately 3.5t, in the Typical Year.

14.6.8 The reduction in polluting load that would be discharged from the CSO with the project in place would be as follows:

14.6.9 For Brixton Storm Relief CSO:

a. the CSO would discharge 560kg of BOD in the Typical Year (13,440kg less than the operational base case)

b. the CSO would discharge 20kg of ammonia in the Typical Year (450kg less than the operational base case)

c. the CSO would discharge 90kg of TKN in the Typical Year (2,110kg less than the operational base case).

14.6.10 For Clapham Storm Relief CSO:

a. the CSO would discharge 800kg of BOD in the Typical Year (430kg more than the operational base case)

b. the CSO would discharge 30kg of ammonia in the Typical Year (20kg more than the operational base case)

c. the CSO would discharge 130kg of TKN in the Typical Year (100kg more than the operational base case).

14.6.11 Due to the operation of the connection culvert between the Brixton Storm Relief CSO and Clapham Storm Relief CSO (see para 14.2.4), the spills from the two CSOs would be linked, such that when the tunnel penstock is closed, flows from the Brixton Storm Relief CSO would be discharged via the Clapham CSO outfall. This accounts for the decrease in spill volume but increase in loadings shown above.

14.6.12 Catchment modelling of the 2080 development case (to account for the effects of climate change and predicted increases to population) predicts that by 2080 with the operational Thames Tideway Tunnel project, the frequency, duration and volume of the Clapham Storm Relief and Brixton Storm Relief CSOs would be the following:

14.6.13 For Brixton Storm Relief CSO:

a. the CSO would spill on average once per year (the same as the Year 1 of operation development case)

b. the CSO would spill for an average duration of five hours (one hour more than the Year 1 of operation development case)

c. the spill volume from the CSO would be approximately 13,000m^3 per year (7,300m^3 more than the Year 1 of operation development case).

14.6.14 For Clapham Storm Relief CSO:

a. the CSO would spill on average once per year (the same as the 2021 development case)

b. the CSO would spill for an average duration of eight hours (three hours more than the 2021 development case)

c. the spill volume from the CSO would be approximately 16,000m^3 per year (8,100m^3 more than the 2021 development case).

14.6.15 In summary, the model predicts that in the 2080 development case scenario the Clapham Storm Relief and Brixton Storm Relief CSOs at Albert Embankment Foreshore site would maintain spill frequency, but increase in total spill duration and volume. These changes in spill frequency, duration and volume would be due to the impact of climate change, which is expected to lead to fewer, but more intense rainfall events during winter and drier summers.

14.6.16 Climate change is also predicted to increase average water temperatures, which combined with changes to rainfall patterns could affect water quality in the tidal Thames. These water quality changes would be realised across the tidal Thames so they have been assessed in Vol 3 Section 14 and climate change is not considered further within the assessment.

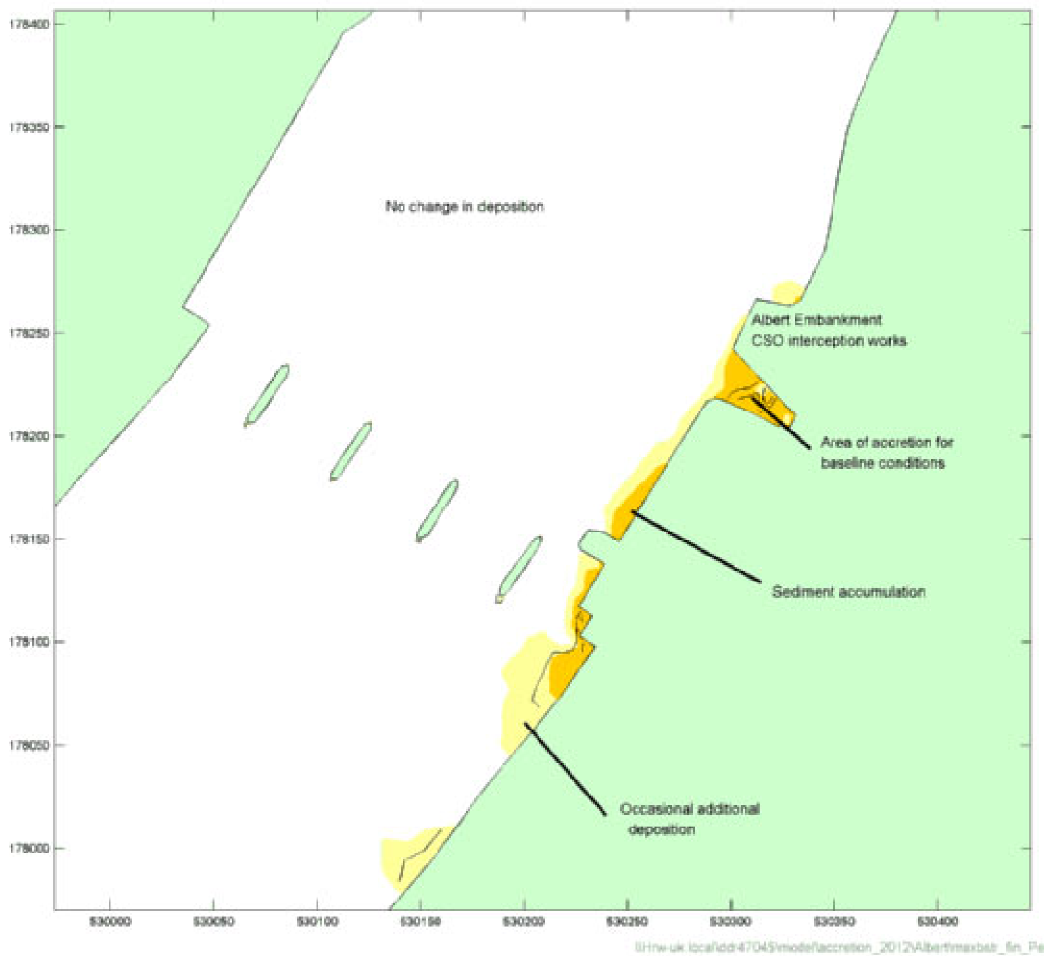
Permanent land take and morphological changes

14.6.17 In order to accommodate the permanent works at the Albert Embankment Foreshore site, construction of permanent structures within the river channel would be required as described in Section 3.2 of this volume. The permanent structure could affect the river regime with the potential that localised increases in flow velocity cause scour of the river bed and foreshore and could result in the mobilisation of suspended solids. The approach to scour protection for the permanent works is described in the *Engineering Design Statement* as described in Section 14.2 and scour is not considered further with the assessment.

Deposition

14.6.18 The permanent works cofferdam would be likely to lead to changes in flows (velocities, directions) and cause changes in deposition of sediments around the Albert Embankment foreshore site. These sediments could be those generated by the project itself but would also include sediments occurring naturally in the water column. Modelling carried out (Vol 3 Appendix L.3) has predicted the extent of this deposition, as shown below in Vol 16 Plate 14.6.1.

Vol 16 Plate 14.6.1 Surface water – prediction deposition around permanent works at the Albert Embankment foreshore site



14.6.19 Most deposition is likely to be localised (as shown above in Vol 16 Plate 14.6.1) and may be remobilised by spring tides (for deposition during neap tides) or by large fluvial flows (for deposition during seasonal low fluvial flows). The overall impact on channel morphology would be negligible.

14.6.20 Impacts on channel morphology from deposition can have an effect on ecological receptors, by changing habitat availability. This effect is assessed in Section 5 of this volume.

Operational effects

Reduction in CSO spills

14.6.21 The reduction in spills from Storm Relief and Brixton Storm Relief CSOs would represent an important contribution towards

a. meeting the requirements of the Urban Waste Water Treatment Directive[13] (UWWTD) in relation to the Storm Relief and Brixton Storm Relief CSOs

b. meeting the required TTSS DO standards

c. moving the tidal Thames towards its target status under the WFD both locally and throughout the tidal Thames.

14.6.22 Therefore, the reduction in spills would be a **major beneficial** effect, most notably in the context of the UWWTD. It should be noted that, as explained in Section 14.1, the water quality in the vicinity of Albert Embankment Foreshore site also depends on the project-wide improvements, as documented in Vol 3 Section 14.

14.6.23 The associated reduction in exposure to pathogens would greatly improve the conditions for recreational users of the tidal Thames around Albert Embankment, allowing the tidal Thames in this location to be used more frequently with a reduced risk of exposure. This is considered to be a **moderate beneficial** effect. As explained in Section 14.4, an assessment of the amenity effects of the sewage litter is given in Vol 3 Section 10 Socio-economics.

14.6.24 The reduction in sewage litter discharge would also improve the aesthetic quality of the tidal Thames locally, improving conditions for recreational users. This is considered to be a **moderate beneficial** effect.

Permanent land take and morphological changes

14.6.25 The permanent structures proposed in the tidal Thames have been designed and engineered to minimise the impediment of flow and although some changes to flows are likely, the changes are unlikely to lead to further substantive deterioration of the morphological condition of the channel which is already modified by flood defences. In addition, the changes in flow are unlikely to lead to an area of slack 'dead' water around the permanent structures. The WFD objectives are not considered to be affected by this change, and hence the effect is considered to be **minor adverse**.

14.6.26 Impacts on channel morphology can also have an effect on ecological receptors, by changing habitat availability. This effect is outside the scope of the surface water assessment and is assessed in Section 5 of this volume.

14.7 Cumulative effects assessment

14.7.1 Considerable improvements in the water quality of the tidal Thames will occur as a result of the works associated with the Lee Tunnel and sewage works upgrades. These already form part of the base case and so are not considered as part of the assessment of cumulative effects.

14.7.2 Of the projects described in Vol 16 Appendix N, which could potentially give rise to cumulative effects with the proposed development at Albert Embankment Foreshore site, is not considered that any would lead to cumulative effects on surface water. This is because the significant adverse effects that are considered likely for the construction and operational phases at this site are associated with the proposed in-river structures. The majority of the developments described in Vol 16 Appendix N are remote from the tidal Thames and are therefore unlikely to have significant effects on the channel morphology.

14.7.3 No significant cumulative effects have therefore been identified for the construction or operational phases at this site and therefore the effects on surface water would remain as described in Section 14.5 and Section 14.6 above.

14.8 Mitigation

14.8.1 No significant adverse effects have been identified and therefore mitigation is required.

14.9 Residual effects assessment

Construction effects

14.9.1 As no mitigation measures are proposed, the residual construction effects remain as described in Section 14.5. All residual effects are presented in Section 14.10.

Operational effects

14.9.2 As no mitigation measures are proposed, the residual operational effects remain as described in Section 14.6. All residual effects are presented in Section 14.10.

14.10 Assessment summary

14.10.1 This topic assessment has considered both access Options A and B and given that there are not anticipated to be any differences, the assessment summary table reflects both options.

Vol 16 Table 14.10.1 Surface water – construction assessment summary

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Thames Middle	Temporary changes to channel morphology (cofferdam and associated scour protection construction)	Minor adverse	None	Minor adverse
Thames Middle	Changes in aesthetic quality due to debris accumulation in slack water between structures	Minor adverse	None	Minor adverse

Vol 18 Table 14.10.2 Surface water – operational assessment summary

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Thames Middle and Thames Upper	Compliance with UWWTD and WFD. Improved water quality in the vicinity of the Clapham Storm Relief and Brixton Storm Relief CSOs by reduced pollutant loading and not reduction of dissolved oxygen levels due to reduced spill frequency, duration and volume from the Clapham Storm Relief and Brixton Storm Relief CSOs	Major beneficial	None	Major beneficial
Thames Middle and Thames Upper	Risk of exposure days to pathogens would be reduced to a maximum of 2 days in the Typical Year (a reduction of up to 140 days of risk of exposure)	Moderate beneficial	None	Moderate beneficial
Thames Middle and Thames	Sewage derived litter discharge at Clapham Storm Relief and Brixton Storm Relief CSOs would be reduced by	Moderate beneficial	None	Moderate beneficial

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Upper	approximately 95% improving the aesthetic quality of the river locally			
Thames Middle	Change in channel morphology caused by permanent foreshore/in-channel structures	Minor adverse	See Section 5 of this volume	Minor adverse

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[1] HM Government. *National Policy Statement for Waste Water: A framework document for planning decisions on nationally significant waste water* (March 2012). Available at: http://www.defra.gov.uk/publications/files/pb13709-waste-water-nps.pdf

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[9] Lane, C, Surman-Lee, S, Sellwood, J and Lee, JV. *The Thames Recreational Users Study Final Report* (2007).

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[13] *The Urban Waste Water Treatment Directive.* See citation above.

Thames Tideway Tunnel
Thames Water Utilities Limited

Thames Water

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.16**

Volume 16: Albert Embankment Foreshore site assessment

Section 15: Water resources - flood risk

APFP Regulations 2009: Regulation **5(2)(a)**

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January 2013

Thames Tideway Tunnel

Creating a cleaner, healthier River Thames

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Thames Tideway Tunnel

Environmental Statement

Volume 16: Albert Embankment Foreshore site assessment

Section 15: Water resources – flood risk

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15 Water resources – flood risk

15.1 Introduction

Background

15.1.1 This section forms a Flood Risk Assessment (FRA) for the Albert Embankment Foreshore site. This FRA has been developed in line with the requirements of the National Policy Statement (NPS) for Waste Water (Defra, 2012)[1] Section 4.4 and includes a qualitative appraisal of the flood risk posed to the site, the potential impact of the development on flood risk on and off the site and an appraisal of the scope of possible measures to reduce the flood risk to acceptable levels. Further details on how the NPS requirements relevant to flood risk have been met can be found in Vol 2 Environmental assessment methodology Table 15.3.1.

15.1.2 The proposed development is described in Section 3 of this volume. Plans of the proposed development as well as figures included in the assessment for this site are contained in a separate volume (Volume 16 Albert Embankment Foreshore Figures).

15.1.3 A summary of the regulations and policy that have informed the assessment are presented in this section. Section 15.2 provides a summary of the proposed development in relation to flood risk. Section 15.3 provides an assessment of the flood risk to the site and elsewhere as a result of the development, during both the construction and operational phases. Section 15.4 provides details of the design measures that have been adopted within the proposals to ensure the flood risk to the site is not increased and ensure that flood risk does not increase elsewhere.

15.1.4 The assessment of flood risk should be considered in conjunction with the assessment of other water resources ie, groundwater and surface water. The assessment of effects on groundwater is presented in Section 13 Water resources – groundwater. The assessment of effects on surface water is presented in Section 14 Water resources – surface water.

15.1.5 A project-wide FRA has been undertaken and is presented in Volume 3 Project-wide assessment.

Regulatory context

15.1.6 The NPS seeks to ensure that where the development of new waste water infrastructure is necessary in areas at risk of flooding, flood risk from all sources of flooding is taken into account at all stages in the planning process in order for the development to be safe without increasing flood risk elsewhere.

15.1.7 A review of planning policy relevant to the proposed development is provided in Vol 16 Appendix M.1.

NPS Sequential and Exception Tests

15.1.8 The Waste Water NPS aims to direct development towards low risk areas through the use of a sequential approach which avoids inappropriate development in areas at risk of flooding. Using this approach, preference should be given to locating projects in Flood Zone 1 although if there is no 'reasonably available site' in Flood Zone 1 then projects should be located in Flood Zone 2. However if there is no 'reasonably available site' in Flood Zones 1 or 2, then nationally significant waste water infrastructure projects can be located in Flood Zone 3 subject to the Exception Test.

15.1.9 The NPS states that the Exception Test should be applied where it is not possible for the project to be located in zones of lower probability of flooding than Flood Zone 3.

15.1.10 The Exception Test is detailed in Section 4.4.15 of the NPS. The test requires overall sustainability benefits (Part A) to outweigh flood risk, whilst ensuring the development is safe and does not increase flood risk elsewhere (Part C) and is preferably located on previously developed land (Part B).

15.1.11 The overall project is considered to pass the Sequential Test, as detailed in Vol 3 Section 15. The project-wide Exception Test is also detailed in Vol 3 Section 15.

15.1.12 The proposed development at Albert Embankment Foreshore would form an integral part of the Thames Tideway Tunnel project and so would help achieve the project-wide sustainability benefits outlined in the *Sustainability statement*. Given the project-wide sustainability benefits, the proposed development is considered to satisfy part a) of the Exception Test.

15.1.13 The proposed development would not be located on previously - developed land. However, as detailed in Vol 3 Section 15 no reasonably alternative sites on developable previously- developed land were identified during the site selection process and as such the proposed development at Albert Embankment would satisfy part b) of the Exception Test.

15.1.14 This FRA shows that the proposed development would be appropriate for the area as flood risk to the development would be managed through appropriate design measures such as constructing new flood defences to protect the site to the 1 in 1000 year standard. As such, the development can be considered safe and the development would not lead to a significant increase in flood risk on the surrounding areas. Therefore, part c) of the Exception Test has also been met.

15.2 Elements of the proposed development relevant to flood risk

15.2.1 The proposed development at this site is described in Section 3 of this volume. The elements of the proposed development relevant to flood risk are set out below.

Construction

15.2.2 Two access options have been considered: Option A is via Lack's Dock and Option B involves the construction of a temporary road access between Camelford House and Tintagel House. Both options are located within the defended floodplain of the tidal Thames and the two routes would have the same impact/effect on flood risk.

15.2.3 During the construction phase the following elements are proposed that are relevant to flood risk:

a. Two separate cofferdams would be constructed to the same height as the existing flood defence. The first cofferdam would be constructed around the works area under Vauxhall Bridge and the second would be constructed around the combined sewer overflow (CSO) drop shaft.

b. A temporary campshed would be constructed adjacent to the CSO drop shaft temporary cofferdam boundary to allow mooring of barges.

c. The works under Vauxhall Bridge would involve removal of the parapet of a section of flood defence wall to provide access to the interception structure. The temporary cofferdam would maintain a continuous flood defence.

d. The works for the CSO drop shaft would involve removal of the parapet of a section of flood defence wall to provide access to the shaft structure. The temporary cofferdam would maintain a continuous flood defence.

e. Four surface water drainage outfalls to the north of Lacks Dock would be extended to the proposed river wall. Two surface water drainage outfalls would be extended to the proposed outer terrace north of Vauxhall Bridge. The existing Clapham and Brixton Storm Relief CSOs at the Albert Embankment Foreshore site would be maintained throughout the construction period by an extension through the cofferdam. This would allow the CSOs to remain operational during the construction period.

f. The Brixton and Clapham Storm Relief Outlets would be intercepted. To enable this, a connection culvert would be constructed to the south of Vauxhall Bridge to connect the existing Clapham Storm Relief Outlet to the combined flow interception and valve chamber. A separate culvert would connect the Brixton Storm Relief Sewer to the interception and valve chamber north of Vauxhall Bridge. A connection culvert would transfer flows from the interception and valve chamber to the CSO drop shaft, which would itself be connected to the main tunnel by a connection tunnel.

Code of construction practice

15.2.4 Appropriate guidance regarding flood defence construction and emergency planning are included in the *Code of Construction Practice* (CoCP*)*. The CoCP is provided in Vol 1 Appendix A. It contains general requirements (Part A), and site specific requirements for this site (Part B).

15.2.5 The CoCP (Section 8) states that no temporary living accommodation would be permitted onsite and that an evacuation route and safe refuge should be provided in the event of a flood event.

15.2.6 The CoCP (Section 8) states that the contractor would be responsible for providing and maintaining continuous flood defence provision, for both permanent and temporary works, to the statutory flood defence level[i] as detailed within the FRA. This is a requirement of the Thames River Protection of Floods Amendment Act 1879[2].

Operation

15.2.7 As part of the permanent works the following elements relevant to flood risk are proposed:

a. A new flood defence wall would be constructed along the embankment adjacent to the CSO site. This would be designed to allow future raising in accordance with the Thames Estuary 2100 Plan consultation document (TE2100) (EA, 2009)[3] requirements. The crest level of the new flood defence would be set at the existing level of the flood defence and would be tied into adjacent flood defences. The flood defence wall associated with the works under Vauxhall Bridge would be retained as part of the permanent works.

b. Floodable vegetated inter-tidal terraces would be constructed below the high tide level around the interception structure, and over the connection culvert joining the Clapham Storm Relief Sewer CSO outfall to the interception chamber. A raised section would be defended through the creation of a new flood defence wall and would allow for future raising in accordance with TE2100 requirements.

c. The outfalls from the Clapham and Brixton Storm Relief CSOs would be intercepted. The CSO outfalls would remain operational and would spill only when the main tunnel reaches capacity or is unavailable. These outfalls would be reconstructed and extended past the terracing into the tidal reaches of the River Thames (tidal Thames).

d. As the site is adjacent to the tidal Thames surface water runoff associated with the impermeable surfaces on the site would be discharged directly into the River Thames.

15.3 Assessment of flood risk

Introduction

15.3.1 The Waste Water NPS requires that all potential sources of flooding that could affect the proposed development are considered.

15.3.2 This assessment is based on an FRA screening exercise that identified relevant potential flood sources and pathways. The tidal and fluvial

[i] The level to which the flood defences must be maintained to ensure that both the sites themselves and third-party land and assets in the surrounding area are protected from flooding.

assessments were based on the flood zones which do not take account of the presence of existing defences.

15.3.3 The assessment of flood risk from the proposed development takes into account the proposed design measures detailed in 15.4.

15.3.4 It should be noted that due to the nature of a flood risk assessment, the risk based approach outlined in the *National Planning Policy Framework* NPPF (Communities and Local Government, 2012)[4] was considered to be preferable to the general environmental impact assessment (EIA) methodology described in Vol 2, Section 3. This approach is based on the probability of an event occurring as a result of the proposed development rather than a direct change in conditions. This is detailed further in the methodology (see Vol.2).

Tidal flood risk to the proposed development

Level of flood risk based on flood zones

15.3.5 The Albert Embankment Foreshore site is situated within the tidal foreshore of the River Thames, adjacent to the southern river bank, underneath and to the north of Vauxhall Bridge. Lacks Dock is situated between the area of the site where the CSOs would be intercepted and the area of the site used for the location of the CSO drop shaft.

15.3.6 The Environment Agency (EA) Flood Map identifies the adjacent riverfront area as lying within Flood Zone 3. The location of the site in relation to the flood zones is shown in Vol 16 Figure 15.3.1 (see separate volume of figures). As the site is located within the foreshore, it is part of the active floodplain of the tidal Thames and subject to daily tidal inundation. This area is therefore considered as functional floodplain and is classified as Flood Zone 3b (land where water has to flow or be stored in times of flood). Due to the undefended nature of the floodplain at this location and the frequency at which tidal inundation occurs, the current risk of flooding to this foreshore part of the site (without the design measures) is considered to be very high (see methodology in Vol 2).

Existing tidal defences

15.3.7 A raised flood defence wall is aligned along the boundary of the River Thames. The defence wall is landward of the proposed site (which is located in the foreshore) and the site is therefore not protected from tidal flooding by flood defences other than the Thames Barrier located approximately 18km downstream.

15.3.8 The EA stated that the statutory flood defence level relevant to the Albert Embankment Foreshore site is 5.41m Above Ordnance Datum (AOD).

15.3.9 The National Flood and Coastal Defence Database (NFCDD) (EA, 2011)[5] identified the crest level of the flood defences adjacent to the site along the northern bank of Lacks Dock at 5.84mAOD. Further to the north flood defence crest levels are 5.83m. Crest levels of two river wall sections aligned along Lacks Dock and an area to the south adjacent to the Vauxhall Cross building are 5.32mAOD. To the south the crest levels of the flood defences is 5.41mAOD. Therefore a section of the existing local flood defences falls below the current statutory level.

15.3.10 Conditions surveys of the flood defences carried out by the EA in February 2011 (EA, 2012)[6] state that the flood defences are overall in good condition (Grade 2), with some areas in fair condition (Grade 3).

15.3.11 The adjacent land behind the foreshore site is protected from flooding by defences, but floodwaters could inundate the area in the event of overtopping (for example if the Thames Barrier fails to close during a tidal event) or a failure of the flood defences as a result of a breach.

15.3.12 The Strategic Flood Risk Assessment (SFRA) for the London Borough (LB) of Lambeth (Scott Wilson Ltd , 2008)[7] quantifies the residual risk in the event of a breach in the local defence wall or overtopping as a result of a failure of the Thames Barrier. The area of land adjacent to the Albert Embankment Foreshore site is designated in the SFRA as an area of low to high (Defra and EA , 2006)[8] hazard[ii]. However, this risk is residual and is not considered to compromise the long term operational function of the tunnel. Further detail regarding residual risk is provided within para. 15.5.3.

Tidal flood level modelling

15.3.13 The most extreme flood risk scenario that could affect the site would be a combination of a high tide with a storm surge in the Thames Estuary. This scenario, assuming the Thames Barrier is operational, is the EA's 'design flood' event, a hypothetical flood event representing a specific likelihood of occurrence, in this case the 1 in 200 year (0.5% Annual Exceedance Probability [AEP][iii]) flood event.

15.3.14 The EA Thames Tidal Defences Joint Probability Extreme Water Level Study (EA, 2008)[9] provides modelled tidal flood levels for the 1 in 200 year (0.5% AEP) flood event for specific locations (model node locations) within the River Thames.

15.3.15 Vol 16 Table 15.3.1 presents the modelled tidal levels from this study for model node 2.31 which is the most relevant (ie, closest) to the site (Vol 16 Figure 15.3.1, see separate volume of figures). It should be noted that the water levels are expected to decrease in the future due to an amended future Thames Barrier closure rule (see Vol 2) therefore the 2005 scenario (ie, the present day scenario provided by the EA) produces the highest water level.

15.3.16 Vol 16 Table 15.3.1 also confirms that the existing defence levels at the site are above the 0.5% AEP tidal flood level; therefore the adjacent land behind the flood defences is protected from tidal flooding up to and above the 0.5% AEP tidal flood event.

[ii] Designated using a combination of consequence and distance from the defence as per the Defra publication 'Flood Risks to People'.

[iii] A flood with a 0.5% Annual Exceedance Probability has a one in 200 year probability of occurring

Vol 16 Table 15.3.1 Flood risk – water levels

Return period	Flood level (mAOD)	Statutory flood defence level (mAOD)	Lowest flood defence level (mAOD)
0.5% AEP (2005)	4.99	5.41	5.32
0.5% AEP (2107)	4.98		

Tidal risk from the proposed development

New tidal defences

15.3.17 The presence of permanent structures within the foreshore has the potential to influence the flood risk to the site itself and to the surrounding environment. The proposed development includes building a new flood defence at or above existing statutory level. As a result the site which is currently located in Flood Zone 3b would be protected by defences and would be located in Flood Zone 3a and subject to residual risk only, in the event of a breach or overtopping of the flood defences. Due to the location on Flood Zone 3a, the risk of tidal flooding would be considered high (see methodology in Vol 2). Potential risks are described further in paras. 15.3.18 to 15.3.29 and measures included within the design are outlined in Section 15.4.

Flood defence integrity

15.3.18 The tunnel excavation process using tunnel boring manes (TBMs) and other construction methods, has the potential to create differential settlement (that is a gradual downward movement of foundations due to compression of soil which can lead to damage if settlement is uneven), which could affect the level of some of the existing flood defences. The proposed tunnel route runs immediately adjacent to the tidal Thames river wall and therefore has the potential to affect the defences at this site.

15.3.19 The proposed design has been informed by consideration of settlement and the alignment and methods used have been selected to minimise it as far as possible. A potential settlement of between 3mm and 43mm is been estimated (based on information provided by Thames Water) to occur across the river walls at this site. The flood defence levels following settlement is estimated to range from 5.30mAOD to 5.82mAOD. Sections of the river wall could therefore fall below the EAs statutory flood defence level (ie, 5.41mAOD) following settlement of this degree. However, it should be noted that the defences are currently already below the statutory level in this location at 5.32mAOD.

15.3.20 An initial assessment of the effect of construction activities on the structural integrity of flood defences at this site was undertaken by Thames Water. This considered effects from ground movement as well as a range of other construction-related impacts where applicable. The assessment indicated potential structural impacts on the flood defences at the site arising from increased water differential, excavation in front of wall and tie-rod stress[iv] increase.

15.3.21 The proposed schedule of works (Schedule 1 of *The Draft Thames Water Utilities Limited (Thames Tideway Tunnel) Development Consent Order*) includes a provision for "works for the benefit of the protection of land or structures affected by the authorised project" which would provide the powers to mitigate for any impact on the flood defences at the site.

15.3.22 Transportation of materials between the two cofferdams would be along the foreshore and onto the Vauxhall Bridge working area via a ramp over the cofferdam defences. Access to the foreshore would be via Lacks Dock. The construction of an access ramp between the two cofferdams would not have an impact on the local flood defences as it would be placed over the cofferdam defences.

Flood defence line

15.3.23 Both temporary and permanent works to flood defences have the potential to impact on the level of tidal flood risk to the surrounding area. In this case the proposed cofferdam and the new flood defence wall would be constructed to the same height as the existing flood defences ensuring that the level of residual risk and therefore tidal flood risk to adjacent areas remains the same.

Scour management

15.3.24 The TE2100 Plan (EA, 2012)[10] includes an assessment of the tidal Thames foreshore at this location where there are long lengths of naturally eroding reaches of the River Thames. Results from this study show that works within the foreshore at this site may have an influence on downstream river structures if the pattern of sediment movement is greatly changed. In addition, should any permanent and temporary works within the river cause the channel width to be considerably altered, the flow velocity of the river at this point may vary, thereby altering contraction scour across the channel bed.

15.3.25 A scour summary report outlines the modelling studies that have been undertaken to determine the magnitude of scour associated with both the temporary and permanent works at ten foreshore sites on the tidalThames (Vol.3, Appendix L.3) including the Albert Embankment Foreshore site.

15.3.26 Scour is predicted at the Albert Embankment Foreshore site to be greatest during construction with maximum estimated scour depths to temporary works of up to 1m. The contraction scour has been estimated during construction to be less than0.1m across the river bed and less than 0.1m at the adjacent river walls.

15.3.27 During the permanent works local scour depths of up to 1m are predicted around the permanent works. Contraction scour has been estimated to be

[iv] Tie-rod stress analysis aims to determine the likely tie-rod stress change as a result of differential ground movement between a river wall and its anchor, caused by tunnel construction.

less than0.1m. As a proactive approach permanent scour protection is envisaged at the base of the new flood defence wall.

15.3.28 Both the temporary and permanent works have the potential to influence scour and /or deposition rates within the river and affect river structures including flood defences.

Loss of volume from the tideway

15.3.29 The presence of temporary and permanent structures within the foreshore has the potential to reduce the availability of flood storage within the River Thames. The impact of the removal of flood storage on flood levels may propagate throughout the hydrological unit of the Thames reach and has been modelled on a project-wide basis.

15.3.30 The Albert Embankment Foreshore site is located within the reach of Westminster to Tower in the tidal and fluvial modelling study. The modelling identifies that for this reach the potential maximum decrease in peak water level is 0.007m during the temporary works scenario reducing to 0.002m during the permanent scenario. The modelling also identifies a potential maximum increase of 0.012m in peak water level during the temporary works scenario reducing to 0.004m during the permanent scenario. As identified in para.15.3.16 a section of the flood defences at this site fall below the statutory level and the surrounding flood defences are above the statutory flood defence level. When the flood defence levels are compared to the 1 in 200 year tidal level for the year 2107 these would provide between 0.34-0.86m in freeboard. These predicted changes in water level and freeboard are not considered to reduce flood protection at this site below design standard requirements and are therefore not deemed significant.

15.3.31 The results of the above modelling exercise show that the proposed project –wide works (both temporary and permanent works) are not considered to have a detrimental impact on the flood storage or tidal levels within the tidal Thames. This is discussed further in Vol 3 Section 15.

Fluvial flood risk to the proposed development

Level of flood risk based on flood zones

15.3.32 At this location along the River Thames, both fluvial and tidal inputs are component parts of the resulting water level. The results of flooding from the tidal influence of the tidal Thames are judged to be of greater importance than those from fluvial influences. As the Albert Embankment Foreshore site is located within Flood Zone 3b, and as the tidal and fluvial floodplain cannot be distinguished from each other at this location the risk of flooding from this flood source is considered to be very high. Further detail is included in Vol 2.

15.3.33 The 'Lost River' Effra joins the tidal Thames at the southwest of the site, via the Brixton Storm Relief CSO. The Surface Water Management Plan (SWMP) for Lambeth (Capita Symonds and Scott Wilson, 2011)[11] states that the River Effra flows through a combined Storm Relief Sewer through Lambeth. As such, the River Effra does not have a fluvial impact on the site. This risk of flooding from this source is therefore not assessed in this section. The associated surface water and sewer flood risk is addressed in the following sections.

Fluvial flood risk from the proposed development

15.3.34 The site is located in the functional floodplain of the River Thames. Fluvial influences were also considered when developing the hydraulic modelling summarised in para. 15.3.31. Overall, the results of the modelling exercise show that the proposed project-wide works are not considered to have a detrimental impact on the flood storage or tidal levels within the River Thames. This is discussed further in Vol 3 Section 15.

Surface water flood risk to the proposed development

15.3.35 Flooding of land from surface water runoff is usually caused by heavy rainfall that is unable to infiltrate into the ground or drain quickly enough into the local drainage network. Flooding can also occur at locations where the drainage network system is at full capacity and floodwater is not able to enter the system. This form of flooding often occurs in lower lying areas where the drainage system is unable to cope with the volume of water.

15.3.36 As part of the Drain London Project[v], a Surface Water Management Plan (SWMP) was prepared for the LB of Lambeth (Capita Symonds and Scott Wilson, 2011)[12]. This shows that the land adjacent to the Albert Embankment Foreshore site is not located within a Critical Drainage Area (CDA)[vi] which suggests that it is relatively less susceptible to surface water flooding than other local areas in the borough. Modelling results for a 1 in 100 year (1% AEP) rainfall event plus climate change allowance show only small isolated areas of potential surface water flooding of up to 0.5m. These are specifically located in lower lying areas adjacent to the raised Vauxhall Bridge.

15.3.37 Surface water flooding could originate from any surrounding hard standing areas. The site and areas adjacent to the foreshore are hard standing. The Thames Path which runs adjacent to the river wall is at a level of around 5mAOD, decreasing towards the subway under the Vauxhall Bridge. The Vauxhall Bridge is at approximately 9mAOD as it passes parallel to the site. Surface water runoff from the Vauxhall Bridge road and surrounding area could potentially accumulate in the low lying areas of the site, adjacent to the bridge. The land adjacent to the CSO drop shaft has a level of approximately 5mAOD, decreasing towards the north. There is a limited area that would contribute to surface water runoff at this point. Surface water flood incidents identified in the SWMP, approximately 300m to the east of the Albert Embankment site, have occurred in areas of low elevation but there are no apparent flow paths from these locations to the site.

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[v] A London wide strategic surface water management study undertaken by the Greater London Authority (GLA) and London Councils)

[vi] Area susceptible to surface water flooding

15.3.38 The 'Lost River' Effra joins the tidal Thames at the southwest of the site, via the Brixton Storm Relief CSO. Significant surface water flood risk is identified by the SWMP along the paths of the 'lost rivers'. However, the area near Vauxhall Bridge is not specifically highlighted.

15.3.39 As the SWMP indicates the potential for flood depths of up to 0.5m and there are limited pathways present, the flood risk form this source is considered to be medium (see methodology in Vol 2).

Surface water flood risk from the proposed development

15.3.40 An assessment of the potential effects of surface water from the Albert Embankment Foreshore site is provided in Section 14 of this volume.

15.3.41 The NPS requires that surface water runoff on new developments is effectively managed so that the risk of surface water flooding to the surrounding area is not increased. In accordance with NPS, runoff rates following the proposed development should not be greater than the existing (pre-development) rates.

15.3.42 The majority of the Albert Embankment Foreshore site naturally drains directly to the tidal Thames without inundating surrounding land. In agreement with the EA (as set out in their phase two consultation response), surface water runoff from the proposed site would also be discharged directly to the River Thames. Due to the tidal nature of the receiving watercourse, surface water runoff rates to the Thames would not increase surface water flood risk to the site or surrounding area and would therefore not require attenuation prior to discharge.

15.3.43 In the event of a storm coinciding with a high tide event, surface water drainage from the site would be restricted and would need to be stored on site. If necessary, on-site storage would therefore be provided to manage the risk of site flooding in the event of tide-locking of the surface water outfall.

15.3.44 Following the implementation of the above drainage measures the risk of flooding as a result of the proposed development would be unchanged and remain as medium.

Groundwater flood risk to the proposed development

15.3.45 Groundwater flooding occurs where groundwater levels rise above ground surface levels. Groundwater levels have been recorded by Thames Water for the nearest borehole SR1078 between May 2009 and July 2011 (located approximately 50m from the site). At this location the water levels in the upper aquifer, in the river terrace deposits, average approximately 5.3m below ground level (bgl). The water levels fluctuate below the top of the river terrace deposits (at 4.6m bgl at this site), suggesting that the upper aquifer is not entirely saturated.

15.3.46 The lower aquifer is confined beneath Lambeth Group and London Clay Formations.

15.3.47 The SWMP for Lambeth details one reported groundwater flooding incident in the vicinity of the site in the period 2000-2010, approximately 100m to the east of the site.

15.3.48 As the groundwater levels are 5.3m bgl the risk of groundwater flooding is considered to be low (see methodology in Vol 2)

Groundwater flood risk from the proposed development

15.3.49 An assessment of the likely effects on groundwater at the Albert Embankment site is provided in Section 13 of this volume.

15.3.50 The CSO drop shaft would pass through alluvium, river terrace deposits, London Clay, Harwich Formation and Lambeth Group. The below ground construction of the shaft and tunnel would be predominantly in the London Clay layer and though would extend into the Lower Mottled Beds of the Lambeth Group. Depressurisation and dewatering is anticipated to be required for the lower aquifer. Groundwater brought to the surface as a result of dewatering during construction would be pumped from the construction site to the tidal Thames following any necessary treatment. Secant or sheet pilling would be constructed into the London Clay Formation around the Albert Embankment Foreshore site to seal out water held within the upper aquifer.

15.3.51 The presence of the CSO drop shaft creating a physical barrier has been assessed as having a predicted rise in water levels in the upper aquifer of 0.2m during construction and <0.1m during operation. This is considered to be a negligible impact on the water levels of the upper aquifer. The impact of the CSO drop shaft extending approximately 0.4m into the lower aquifer is also considered to be negligible and therefore there is no increase in the risk from groundwater flooding to the site as a result of the development.

Sewers flood risk to the proposed development

15.3.52 The local sewer network includes a 381mm sewer and a 300mm diameter sewer (both combined) running southwards along the Albert Embankment carriageway, east of the Albert Embankment site. There are a number of manholes located along these sewers. There are two abandoned sewers, one of which was formerly a section of the Brixton Storm Relief Sewer, located underneath Bridgefoot Road. Two 230mm diameter combined sewers run in a roughly west to east direction from Bridgefoot Road, commencing immediately to the east of the Albert Embankment site. Numerous manholes are located along these sewers.

15.3.53 The 2515mm x 1676mm Clapham Storm Relief CSO outfalls directly onto the foreshore at the west of the abutment of Vauxhall Bridge at the south end of the site. The 3353mm x 2286mm Brixton Storm Relief sewer outfalls directly onto the foreshore at the east end of the abutment of Vauxhall Bridge within the proposed site.

15.3.54 The southern Low Level Sewer No. 1 (Main Line) runs adjacent to the River Thames, before running in a roughly west to east direction approximately 100m to the east of the Albert Embankment site. The Low Level Sewer No. 1 (Main Line) is also connected to the Clapham Storm Relief Outlet by the 1829mm diameter Vauxhall Connecting Sewer. Downstream of this connection the 1372mm by 914mm Effra Sewer (South Lambeth Road Section) connects to the Low Level Sewer No. 1.

15.3.55 The 381mm combined sewer running south along Albert Embankment connects to the southern Low Level Sewer No. 1 approximately 100m east of the Albert Embankment Foreshore site.

15.3.56 The capacity of the Clapham and Brixton Storm Relief Outlets is unlikely to be exceeded as they are designed to discharge to the River Thames. In the event that the local combined sewers reach capacity, sewage could surcharge through gullies and manholes along the reach of the sewer. Manholes are located along the local combined sewers and therefore there is a presence of potential pathways for sewage to the site.

15.3.57 The two smaller sewers running along Albert Embankment are located a considerable distance from the site and therefore it is unlikely that sewer flooding would inundate the site from these sources. The same is likely to apply to the southern Low Level Sewer No. 1. Sewage from the combined sewers under Bridgefoot Road could potentially flow towards the site.

15.3.58 Thames Water flooding records (Thames Water, 2012)[13] show that there has been 1 record of flooding within 200m of the site since 1990.

15.3.59 Although there is a low incidence of sewer flooding in the area due to the presence of potential pathways for sewage from the combined sewers, the flood risk from this source is considered to be medium (see methodology in Vol 2).

Sewers flood risk from the proposed development

15.3.60 Following construction of the proposed development the Clapham and Brixton Storm Relief sewers would be connected to the main tunnel.

15.3.61 It is proposed that the Clapham and Brixton Storm Relief sewers would be intercepted towards the south of the Albert Embankment Foreshore site so that flows are diverted to the main tunnel via the Albert Embankment Foreshore CSO drop shaft. The sewers would be extended through the temporary cofferdam during construction and would be fully enclosed with flap valves to prevent tidal surcharge. This flood risk would be managed using design measures described in Section 15.4.

15.3.62 The CSO interception and connections have been designed so that there is no increased flooding risk in the existing system for the 1 in 15 year design storm when compared to the base case scenario[vii]. Further detail is provided in Vol 3 Section 15.

15.3.63 At present sewage discharges from the Clapham and Brixton CSO when the capacity of the local combined sewer network is exceeded. Following construction, there would only be a restriction on sewage flows entering the main tunnel should the tunnel be full or unavailable. In this situation, flows would overflow from the interception chamber and discharge to the river.

[vii] The base case scenario comprises the sewage treatment works (STW) Improvements and Lee Tunnel in 2020s.

15.3.64 Following the construction of the proposed development the risk of flooding from this source would be unchanged and therefore would remain medium.

Artificial sources to and from development

15.3.65 There are no nearby artificial flood sources eg, canals, reservoirs, which could lead to flooding of the site.

15.3.66 The flood risk from this source both to and from the proposed development is not applicable at this site and therefore it has not been assessed further.

15.4 Design measures

15.4.1 Design measures have been incorporated into the design of the proposed development to ensure that the risk of flooding to and from the site and surrounding areas is not increased during the construction and operational phases. These measures are described below although many have already been referred to in the preceding section.

Tidal and fluvial

Construction

Flood defences

15.4.2 As discussed in para. 15.3.18 the proposed tunnel alignment runs adjacent to the river wall flood defence and has the potential to affect the integrity of the defences. During construction the level of the flood defences at the site would be monitored and mitigated in agreement with the asset owner and the EA as appropriate, to ensure crest heights of the flood defences at the site are maintained to the existing crest level. With this strategy in place no effects of settlement are anticipated.

15.4.3 Design options to preserve the structural stability of the flood defences at this site would be dependent on the contractor's construction methodology. Potential options for increased water differential in the western part of the site may include perforation of the existing wall.

15.4.4 Suitable construction methods would be used to ensure no adverse impact from excavation in front of the walls at this location. Potential options for tie rod stress increase in the section of wall in front of Vauxhall Cross may include strengthening works to the existing wall. Potential options for the impact to the river wall at the eastern part of the site from increased water differential may include temporarily supporting the wall within the temporary cofferdam while it is unfilled.

15.4.5 As discussed in para. 15.2.3 two separate cofferdams would be constructed to the same height as the existing flood defence level. Transport of material between the two cofferdams would be along the foreshore and onto the interception chamber working area via a ramp over the cofferdam defences. This would ensure that the current level of flood protection and flood risk is maintained during construction. Further information is included in the CoCP (Section 8).

15.4.6 Appropriate Protection Provisions would be agreed with the EA for any works within 16m of the flood defences on the landward side and within the river.

Scour management

15.4.7 During construction the formation of scour would be monitored and mitigation proposed if the scour exceeds agreed trigger values.

15.4.8 Mitigation options could include riprap or rock fill, articulated concrete blocks, gabion mattresses and grout filled mattresses. The detailed approach to the implementation of these mitigation measures would be informed by the monitoring results as well as site specific design requirements. Further details are provided in *Scour Monitoring and Mitigation Strategy* (Vol 3 Appendix L.4).

Emergency plan

15.4.9 Appropriate emergency planning procedures would be adopted by the contractor during the construction phase to mitigate the potential consequences in the event of a breach in the flood defence wall at the site or a failure of the Thames Barrier. Further information is included within the CoCP (Section 8).

Operation

Flood Defences

15.4.10 The permanent operational areas would be protected from flooding through the provision of a new flood defence walls as outlined in para. 15.2.7. The sections of flood defence would tie into existing flood defences, providing a continuous defence line along the Embankment at all times. The new defences would be designed to ensure that future flood defence raising can be achieved to meet the TE2100 requirements.

15.4.11 As the new flood defence wall would be constructed at and above the level of the existing flood defence the residual flood risk to the site would be unchanged compared to the risk behind the existing defences. As detailed in para. 15.5.3 and Vol 3 Section 15, the residual risk to the site is considered to be appropriate and no further measures are required.

Loss of volume from the tideway

15.4.12 As discussed in para. 15.3.29, the result of removal of tideway flood storage on flood levels has been considered on a project-wide basis and is discussed further in Vol 3 Section 15. The floodplain volume loss from river structures has been minimised whilst maintaining fundamental engineering requirements and therefore no further measures are proposed.

Scour management

15.4.13 The shape of the protrusion for the permanent works has been designed to minimise the influence on river on the flow regime of the tidal Thames.

15.4.14 As a proactive approach permanent scour protection would be provided at the toe of the new flood defence river wall. It is assumed for the assessment that permanent scour protection would consist of loose large stone placed just below foreshore level. The size and type of the stone is yet to be defined. It is assumed therefore that a 1m depth of stone would be placed up to 0.5m below the existing foreshore level within the zone indicated on the site works parameter plan (see separate volume of figures - Section 1). It is assumed that these works would be undertaken towards the end of the construction period. This permanent protection would be within the area of the temporary cofferdam.

Emergency plan

15.4.15 During the operational phase the site would not be permanently staffed with the exception of visits from maintenance personnel. An emergency plan would only be required for staff undertaking maintenance visits.

Surface water

Construction

15.4.16 In accordance with the CoCP (Section 8) all site drainage during construction would be drained and discharged to mains foul or combined sewers and where this is not practicable, the site would be drained such that accumulating surface water would be directed to holding or settling tanks, separators and other measures prior to discharge to the combined or surface water drains. Foul drainage from the site welfare facilities would be connected to the mains foul or combined sewer. This approach would ensure that the risk of surface water flooding is managed during construction but would not reduce the overall level of flood risk associated with surface water.

Operation

Scour management – surface water discharge

15.4.17 As outlined in para. 15.3.33 it is intended to discharge surface water from the operational site directly into the tidal Thames. This outfall would be of appropriate size for the potential discharge volumes. Scour protection is included within the operational layout. This would provide sufficient scour protection for the surface water outfall.

Surface water management

15.4.18 As described in para. 15.3.39, surface water runoff from the proposed site would be discharged directly to the tidal Thames. Due to the tidal nature of the receiving watercourse, surface water runoff rates to the Thames would not increase surface water flood risk to the site or surrounding area and would therefore not require attenuation prior to discharge.

Groundwater

Construction and operation

15.4.19 Groundwater monitoring is proposed during construction and operation. Further measures regarding dewatering and maintaining groundwater levels are described in Section 13 of this volume.

Sewers

Construction

15.4.20 The existing Clapham and Brixton Storm Relief CSOs at the Albert Embankment Foreshore site would be maintained throughout the construction period by extensions through the cofferdam. The sewers would be fully enclosed with flap valves to prevent tidal surcharge.

15.4.21 Four existing surface water drainage outfalls to the north of Lacks Dock (all smaller than 250mm in diameter) would all be extended to the proposed river wall. Two existing surface water drainage outfalls (both smaller than 300mm in diameter) would be extended to the proposed outer terrace north of Vauxhall Bridge.

Operation

15.4.22 The Clapham and Brixton Storm Relief CSOs would be re-arranged in the operational site so that they discharge onto a new foreshore outfall apron when the main tunnel is full.

15.4.23 Following construction, there would only be a restriction on sewage flows entering the main tunnel should the tunnel be full or unavailable. In this situation, flows would overflow from the interception chamber and discharge to the River Thames, ensuring the flood risk is not increased compared to the existing situation.

15.5 Assessment summary

Flood risk

15.5.1 The Albert Embankment Foreshore site is located in Flood Zone 3b associated with the tidal Thames. As part of the proposed development, flood defences would be constructed, providing protection to the site from tidal flooding during both construction and operation.

15.5.2 In line with the NPS, this FRA shows that the proposed development would be appropriate for the area as flood risk to the development would remain unchanged as it would be managed through appropriate design measures and the development would not lead to a significant increase in flood risk on the surrounding areas. Therefore no significant flood risk effects are likely. Vol 16 Table 15.5.1 provides a summary of the findings of the FRA undertaken for this site.

Residual risk to the development

15.5.3 The residual risk to the site is the risk that remains after all design measures have been incorporated.

15.5.4 Following the construction of the new flood defence wall adjacent to the River Thames, the site would be protected from tidal flooding. The site would be at residual risk of tidal flooding in the event of a breach in the new flood defence wall or overtopping of the defence wall as a result of a failure of the Thames Barrier.

15.5.5 It is considered that the consequence of a breach or failure of flood defences would not compromise the long term operational function of the tunnel and therefore no additional measures above those outlined above are proposed. Further detail is provided in Vol 3 Section 15.

Residual risk from the development

15.5.6 Following the incorporation of the design measures outlined in Vol 16 Table 15.5.1, the level of residual risk from the development to adjacent areas would remain unchanged. The project-wide residual risks are discussed in Vol 3 Section 15.

15.5.7 This topic assessment has considered both access Options A and B and given that there are not anticipated to be any differences, the assessment summary table reflects both options

Vol 16 Table 15.5.1 Flood risk – FRA summary

Source	Pathway	Current flood risk to the proposed development	Design measures	Flood risk from the proposed development (post design measures)	Flood risk to the proposed development post design measures
Tidal	tidal Thames	Very high	Flood Defence height maintained. New flood defences built around the site so site defended from tidal flooding to statutory level (changing the Flood Zone from 3b to 3a). Monitoring of scour and mitigation if trigger value exceeded. Scour protection measures for permanent works Monitoring of flood defence levels and repaired as required to maintain existing crest level.	No increase in tidal flood risk as a result of proposed development.	High due to change from Flood Zone 3b to 3a (but risk is residual only)
Fluvial	tidal Thames	Very high	Flood Defence height maintained New flood defences built around the site so site defended from fluvial flooding to statutory level (changing the Flood Zone from 3b to 3a). Monitoring of scour and mitigation if trigger value exceeded. Scour protection measures for permanent works Monitoring of flood defence levels	No increase in fluvial flood risk as a result of proposed development.	High due to change from Flood Zone 3b to 3a (but risk is residual only)

Source	Pathway	Current flood risk to the proposed development	Design measures	Flood risk from the proposed development (post design measures)	Flood risk to the proposed development post design measures
			and repaired as required to maintain existing crest level.		
Surface water	Surrounding area	Medium	Site drainage in line with CoCP (Section 8) during construction. Discharge surface water to tidal Thames.	No increase in surface water flood risk as a result of proposed development.	Medium
Groundwater	Underlying geology and groundwater levels restricted pathway	Low	Depressurisation and dewatering during construction. Monitoring proposed during construction and operation. Secant pilling around the Albert Embankment Foreshore site.	No increase in groundwater flood risk as a result of proposed development.	Low
Sewers	Local drainage system	Medium	Outfalls extended through cofferdam to allow for maintained operation. Surface water drainage outfalls extended past proposed river wall or terrace structures. Flows diverted to the main tunnel	No increase in sewers flood risk as a result of proposed development.	Medium
Artificial sources	None	Not applicable	Not applicable	Not applicable	Not applicable

** Definitions of these classifications are included in Vol 2*
() indicate the flood risk is residual ie in the event of a failure or overtopping of flood defences

References

[1] Department of Environment, Food and Rural Affairs (Defra), *National Planning Policy for Waste Water* (February 2012).

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