Thames Tideway Tunnel
Thames Water Utilities Limited

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: **6.2.18**

Volume 18 Blackfriars Bridge Foreshore site assessment

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

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Volume 18: Blackfriars Bridge Foreshore site assessment

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Volume 18: Blackfriars Bridge Foreshore site assessment

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Volume 18 Blackfriars Bridge Foreshore site assessment

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 Blackfriars Bridge Foreshore site.

1.1.2 The proposal at this site is to intercept the existing Fleet Main combined sewer overflow (CSO), which currently discharges approximately 21 times in a typical year. The total volume discharged is approximately 521,000m^3 in a typical year. In addition a connection would be made to the northern Low Level Sewer No.1.

1.1.3 The site and environmental context are described in Section 2. The proposed development at the site, 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 (Vol 18 Blackfriars Bridge Foreshore figures and Vol18 Blackfriars Bridge Foreshore appendices). In addition, there is a separate glossary and abbreviations document which explains technical terms used within this assessment.

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Volume 18 Blackfriars Bridge 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 City of London, close to the boundary of the City of Westminster. It comprises sections of the River Thames foreshore to the west and east of Blackfriars Bridge (A201), a section of the westbound ramp leading down from Blackfriars Bridge and areas of the pavement along Victoria Embankment (A3211) and Paul's Walk.

2.1.2 The site comprises two distinct parts: the main construction area, located to the west of, and under, Blackfriars Road Bridge, and a smaller secondary area (Blackfriars Pier), located to the east of Blackfriars Rail Bridge. The purpose of the secondary site is for the construction of a replacement for Blackfriars Millennium Pier which lies within the main construction site. Unless mentioned otherwise, the 'site' hereafter refers to both of these areas.

2.1.3 The site is defined by the limits of land to be acquired or used (LLAU) and covers an area of approximately 3.1 hectares for the main site and 0.8 hectares for the secondary site. The site location and context is shown in Vol 18 Figure 2.1.1 (see separate volume of figures). Vol 18 Plate 2.1.1 below provides an aerial view of the site.

Vol 18 Plate 2.1.1 Blackfriars Bridge Foreshore – aerial photograph

The site is bounded to the north by the A3211 (Victoria Embankment/ Blackfriars Underpass / Upper Thames Street), beyond which are multi-storey office buildings. It is bounded to the east, south and west by the River Thames. To the west of Blackfriars Bridge is Blackfriars Millennium Pier and the President Pier and further to the west is Chrysanthemum

Pier. The general pattern of existing land uses within and around the site is shown in Vol 18 Figure 2.1.2 (see separate volume of figures). A photograph of the Blackfriars Millennium Pier part of the site is included in Vol 18 Plate 2.1.2 below.

Vol 18 Plate 2.1.2 Blackfriars Bridge Foreshore – view from River Thames

2.1.4 Existing access to the site is from the Blackfriars Bridge junction, via the westbound ramp leading down to Victoria Embankment. The closest railway station to the site is the Blackfriars Underground and Overground station located approximately 120m walking distance to the northeast of the main site. The Thames Path public right of way (PRoW) runs through the site along the footpaths of Victoria Embankment and Paul's Walk.

2.1.5 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 Upper floors of Kings Bench Walk – 60m north of the hoarding

b. educational:

   i City of London School – 170m northwest of the Blackfriars Pier site.

   ii There are no education establishments within 250m of the main site hoarding

c. commercial:

   i Specialist sports club – 5m north of the main site hoarding

- ii The President vessel (in its temporary position) – 20m north of the main site hoarding
- iii Buildings between 40 and 60 Victoria Embankment – 30m north of the main site hoarding during construction phases 1 and 2 and 25m north during construction phase 3
- iv Mermaid Conference Centre – 30m north of the Blackfriars Pier site

d. recreational:

- i River Thames – within cofferdam area
- ii Specialist sports facility within the site boundary
- iii Inner Temple Gardens – 25m north of the main site hoarding

2.1.6 Environmental designations for the site and immediate surrounds are shown in Vol 18 Figure 2.1.3 (see separate volume of figures).

2.1.7 The City of London air quality management area (AQMA) includes both Blackfriars Bridge Foreshore sites and is declared for nitrogen dioxide (NO_2) and particulate matter (PM_{10}).

2.1.8 The majority of the site is located within the River Thames and Tidal Tributaries Site of Importance for Nature Conservation (SINC) (Metropolitan level). The Temple Gardens is designated as a SINC (Borough level)

2.1.9 Both Blackfriars Bridge and the embankment wall, upon which sit cast iron lamp standards, are Grade II listed. Additionally, a number of Grade II listed buildings are located close to the site, including: Carmelite House, Sion College, the City of London School and the gate piers to the Inner Temple Garden.

2.1.10 The site lies within the Whitefriars Conservation Area and a limited part lies within the Temples Conservation Area. The site also lies within the City of London Archaeological Priority Area and possesses a protected strategic view of St Paul's Cathedral and the River Prospects from Blackfriars Bridge and the South Bank.

2.1.11 There are no tree preservation orders (TPOs) in effect on the site. In addition to the avenue of trees lining Victoria Embankment which extends into the northern boundary of the main site, there are also a small number of trees in the northwest corner of the secondary site. Trees within the Whitefriars and Temples Conservation Area are indirectly protected by this designation.

2.1.12 There is considered to be a very low potential for contamination at the site. Local geology comprises superficial deposits and made ground overlying the London Clay. The shaft extends into the Thanet sands, a few metres below the interface with the Lambeth group beds below the clay.

2.1.13 The site lies on the Thames Tideway foreshore and hence is considered to be functional floodplain (Flood Zone 3b), ie, where water must flow or be stored during times of flooding.

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Volume 18 Blackfriars Bridge Foreshore site assessment

Section 3: Proposed development

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3 Proposed development

3.1 Overview

3.1.1 The proposed development at Blackfriars Bridge Foreshore would intercept the existing Fleet Main and control other CSOs by connecting to the Low Level Sewer No. 1[i]. A CSO drop shaft would be constructed. An overflow weir chamber to connect to the northern Low Level Sewer No.1 and an interception chamber to connect to the Fleet Main CSO and two connection culverts would be constructed to link the flows to the shaft. The Blackfriars Bridge shaft would be constructed on the line of the main tunnel that would run from Kirtling Street to Chambers Wharf (therefore a connection tunnel would not be constructed at this site).

3.1.2 The geographic extent of the proposals for which development consent (DC) is sought is defined by the LLAU.

3.1.3 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.

3.1.4 Other development may take place and become operational in advance of or during the Thames Tideway Tunnel project thereby changing 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 ('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 18 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.

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[i] By relieving the flow from the Low Level Sewer No. 1 at Chelsea Embankment Foreshore, Victoria Embankment Foreshore and Blackfriars Bridge Foreshore, the flows from ten other CSOs along the north bank of the river would be controlled. This avoids the need for additional sites at or near the ten CSOs from Church Street in Chelsea to Essex Street in the City of Westminster.

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

Vol 18 Table 3.2.1 Blackfriars Bridge Foreshore – plans and documents defining the project

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 18 Blackfriars Bridge Foreshore figures – Section 1
Demolition and site clearance plans (1 to 4)	For approval	Vol 18 Blackfriars Bridge Foreshore figures – Section 1
Access plan	For approval	Vol 18 Blackfriars Bridge Foreshore figures – Section 1
Proposed site features plan 2 of 3	Indicative– but layout of above ground structures is illustrative (nb. plans 1 and 3 of 3 are illustrative only)	Vol 18 Blackfriars Bridge Foreshore figures – Section 1
Proposed landscape plans 1 and 2	Indicative	Vol 18 Blackfriars Bridge Foreshore figures – Section 1
Proposed listed structure interface plans 1 and 2 – Extent of loss of listed river wall	For approval	Vol 18 Blackfriars Bridge Foreshore figures – Section 1
Proposed listed structure interface plans – proposed listed structure interface (for	Indicative	Vol 18 Blackfriars Bridge Foreshore figures – Section 1

Document /Plan Title	Status	Location
river wall and bridge stairs)		
Design intent plans for kiosk, undercroft, amenity kiosk and river wall	Indicative	Vol 18 Blackfriars Bridge Foreshore figures – Section 1
As existing listed structure interface – bridge stairs (west and east)	For information – but maximum extent of loss of listed structures is for approval	Vol 18 Blackfriars Bridge Foreshore figures – Section 1
Permanent President mooring access and plan elevation	For information – but the detail of spanning the listed wall is for approval	Vol 18 Blackfriars Bridge Foreshore figures – Section 1
Design Principles: Generic	For approval	*Design Principles* report Section 3 (see Vol 1 Appendix B)
Design Principles: Site-specific principles (Blackfriars Bridge Foreshore)	For approval	*Design Principles* report Section 4.19 (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 (Blackfriars Bridge Foreshore)	For approval	*CoCP Part B Blackfriars Bridge Foreshore* (see Vol 1 Appendix A)

Description of the proposed works

3.2.3 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).

3.2.4 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.

3.2.5 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

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

a. **Work No. 17a**: Blackfriars Bridge Foreshore CSO drop shaft – A shaft with an internal diameter of up to 24 metres and a depth (to invert level) of 53 metres.

Associated development

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

a. **Work No. 17b**: Blackfriars Bridge Foreshore associated development – Works to intercept and divert flow from the Fleet Main CSO and connect the northern Low Level Sewer No.1 to the Blackfriars Bridge Foreshore CSO drop shaft (Work No.17a) and into the main tunnel (east central) (Work No. 1c), including the following above and below ground works:

   i demolition of the existing Blackfriars Millennium Pier (including associated ramps, steps, and offices adjacent to the Pier) and relocation to the east of Blackfriars Bridge, including dredging, construction of a river piled wall, a new pontoon and means of access including access brows, bank seats and gangways

   ii removal of section of wall to the north of Work No. 17b(i) and construction of pedestrian gate for emergency services access to the relocated pier

   iii dredging and construction of a cofferdam including the placement of fill material, connection to the existing listed river wall, and protection to listed Blackfriars Road Bridge

   iv partial demolition of existing listed and non-listed 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 Nos. 17a and 17b(v), (xi), (xii), and (xiii) and scour protection works, relocation of Fleet Main CSO, and a new CSO outfall apron

   v construction of an interception chamber, overflow weir 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

   vi demolition of existing west bound Victoria Embankment on-slip ramp and its subsequent reconstruction

- vii removal of existing mooring for the President including pontoon and means of access over listed river wall, including access brows, bank seats and gangways, and subsequent reinstatement after construction of Work Nos. 17a and 17b, and modification to the mooring at Chrysanthemum Pier to accommodate temporary mooring of the President
- viii works to the listed Blackfriars Road Bridge to remove and subsequently relocate the existing stairs from the Thames Path and subway and Blackfriars Road Bridge on the west side of the bridge
- ix works to the listed Blackfriars Road Bridge to remove the existing stairs on the east side of the bridge and provision of replacement stairs and lift from the existing Thames Path up to Blackfriars Road Bridge
- x removal and reinstatement of listed features including lamp standards and benches
- xi construction of structures for air management plant and equipment including filters and ventilation columns and associated below ground ducts and chambers
- xii construction of electrical and control kiosks
- xiii construction of pits, chambers, ducts and pipes for cables, hydraulic pipelines, utility connections, utility diversions and drainage
- xiv provision of temporary access from Victoria Embankment and subsequent reinstatement to original layout
- xv provision of permanent access from Victoria Embankment
- xvi construction of amenity building(s)
- xvii works to reprovide access to public toilets and sports club

3.2.8 The maximum heights of above-ground structures, which are for approval, and shown on the Site works parameter plan (see separate volume of figures – Section 1) are as follows:

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

b. Ventilation column(s) serving the Northern Low Level Sewer No.1 = 6.0m

c. Ventilation column(s) serving the Fleet connection culvert = 8m (with minimum 4.0m)

d. Electrical and control kiosks at embankment level = 2.5m

e. Electrical and control kiosks under bridge ramp = 3.0m

3.2.9 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

3.2.10 The works defined by bullet d (relating to car parking only), k, and l (in the list above) are not considered likely to be applicable to the works proposed at this site.

Ancillary works

3.2.11 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*.

3.2.12 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

3.2.13 The works defined by bullet b (in the list above) is not considered likely to be applicable to the works proposed at this site.

Design principles

3.2.14 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).

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

3.2.16 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.

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

Site features and landscaping

3.2.18 The Proposed landscape plans for the Blackfriars Bridge Foreshore site are indicative and therefore have been assessed in the ES as shown with the exception of the possible locations 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.

3.2.19 Tree planting is proposed on the foreshore structure and the embankment.

Code of Construction Practice

3.2.20 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* is provided in Vol 1 Appendix A and 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.

3.2.21 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 Blackfriars Bridge 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) 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 Construction at this site would be likely to commence in 2017 (Site Year 1) and would be completed in 2021 (Site Year 5). The site would be 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 five years and would involve the following main works (with some overlaps):

a. Site Year 1 to 2 - Site set up (approximately 16 months)

b. Site Year 2 to 3 – CSO drop shaft construction (approximately ten months)

c. Site Year 3 to 5 - Construction of other structures (approximately 26 months)

d. Site Year 5 - Completion of works and site restoration (approximately seven months).

3.3.7 This site would adhere to the standard and extended 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 drop shaft construction, tunneling and secondary lining as described below.

3.3.8 Extended working hours would be required at this site to allow for major concrete pours for drop shaft construction including diaphragm wall panels, base slab, roof slab and other large elements. It is assumed that extended hours would be required approximately twice a week during diaphragm walling for a total duration of approximately two and a half months, and 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 City of London Corporation. During these periods only those activities directly connected with the task would be permitted within the varied hours.

Typical construction activities

3.3.9 Vol 18 Table 3.3.1 identifies the construction phasing plans used for the assessment of construction effects. These plans have been prepared to illustrate possible site layouts for the principal construction phases and relevant activities:

Vol 18 Table 3.3.1 Blackfriars Bridge Foreshore – construction phase plans

Document/Plan title	Activities	Status	Location
Construction phases – phase 1, sheet 1 of 2	Site setup	Illustrative	Vol 18 Blackfriars Bridge Foreshore figures – Section 1
Construction phases – phase 1, sheet 2 of 2	Pier relocation	Illustrative	Vol 18 Blackfriars Bridge Foreshore figures – Section 1
Construction phases – phase 2	Drop shaft construction	Illustrative	Vol 18 Blackfriars Bridge Foreshore figures– Section 1
Construction phases – phase 3	Secondary lining Construction of other structures	Illustrative	Vol 18 Blackfriars Bridge Foreshore figures – Section 1

3.3.10 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.

3.3.11 The following construction works are described below:

a. site setup

b. shaft construction

c. tunnel construction

d. 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

3.3.12 Prior to any works commencing the vessel President would be moved to its temporary location upstream at Chrysanthemum Pier.

3.3.13 The Blackfriars Millennium Pier would be moved permanently to a position downstream of Blackfriars Bridge. The foreshore would be dredged as part of construction of the replacement pier. Once operational, it is likely that there would be infrequent localised dredging (for the purpose of this assessment assumed to be annually) and that natural processes would keep the Pier relatively free of sediment build up.

3.3.14 The site boundary would also 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 Victoria Embankment.

3.3.15 One tree in the west of the site on Victoria Embankment would require removal in advance of the works.

3.3.16 Part of the site is currently or occupied by a specialist sports club which would need to be relocated.

3.3.17 The extent of demolition and site clearance works that would be required are shown on the Demolition and site clearance plans (see separate volume of figures – Section 1). The approach to any land remediation that might be required cannot be defined at this stage. However it is assumed that any remediation that is required would occur within this earliest phase of construction and that any associated lorry movements would be substantially lower than the subsequent peak during the main construction phases.

3.3.18 Other site works would include the setting up of the required site access from Victoria Embankment, diversion of the Thames Path, introduction of the required traffic management activities and temporary services and utility diversions (including numerous telecommunications cables, gas pipes, water supply pipes and electricity cables which would require diversion or protection prior to construction).

3.3.19 It has been assumed that a temporary works cofferdam would extend out from the land from the existing river wall to create a working platform during construction. The maximum extent of the temporary works in the river is defined on the Site works parameter plan (see Section 3.2 and separate volume of figures – Section 1).

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 To create additional site area a piled deck would be constructed along the southwestern face of the temporary cofferdam by installing driven tubular piles and decking with steel and timber.

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 drop 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* (Reference TBC). .

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, diaphragm wall rigs, bentonite silos, water tanks, mixing pans, compressors, air receivers, excavators and dumpers for excavated material handling.

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 provide secure supports between which excavation for the diaphragm walls would be undertaken. 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 which creates the full circle of the drop 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 drop shaft. Grouting at the toe of the diaphragm wall or base may also be required to reduce the flow of water. Dewatering would need to be undertaken as described below.

3.3.33 The drop 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 drop shaft would load shaft skips, hoisted by crawler crane, depositing the excavated material 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 drop shaft.

3.3.34 It is anticipated that dewatering would be required. Dewatering wells would be drilled from the surface (external to the shaft). These pumps would be operational during drop shaft construction. It is assumed that extracted ground water would be discharged directly into the tidal Thames after being treated through a settlement system. Extracted water would be sampled on a regular basis to check water quality.

3.3.35 Grouting would be required either side of the shaft to facilitate tunnel boring machine (TBM) break in / break out. This would consist of a block of treated ground, external to the shaft.

3.3.36 Ground treatment may also be required during the interception and CSO works and to the base of the existing river wall.

Tunnel construction

3.3.37 As the Blackfriars Bridge Foreshore drop shaft is online with the main tunnel drive, there is no connection tunnel to be constructed. However a temporary cradle would be constructed to receive the TBM from Kirtling Street and re-launch it to Chambers Wharf.

3.3.38 Tunnel portals with launch and reception seals would be formed in the drop shaft lining. The portals would consist of cast in-situ concrete portal, with sealing arrangement as required, tied to the shaft lining.

Secondary lining of shaft

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.

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

3.3.41 When the secondary lining is complete the internal structures including the vortexes and drop tubes would be shuttered and concreted.

Construction of other structures

3.3.42 The existing storm relief sewers that discharge to the River Thames under Blackfriars Bridge would be maintained during the works.

3.3.43 An overflow weir chamber, connection culvert and valve chamber would connect to the existing northern Low Level Sewer No.1 inside the Victoria Embankment wall to the CSO drop shaft.

3.3.44 To construct the overflow weir chamber on the Low Level Sewer No.1, the services above the sewer would be diverted or supported and protected where possible. It is anticipated that traffic management would be required for both the utility diversions and the overflow weir chamber construction.

3.3.45 The Low Level Sewer No.1 would be lined before the overflow weir chamber is constructed. The overflow weir chamber would be constructed using secant or sheet piles and excavated exposing the low level sewer. The base slab and internal walls would then be constructed. Flow would be temporarily diverted from the Low Level Sewer No.1 to allow the existing sewer to be broken out on completion of the weir chamber.

3.3.46 Sheet pile walls would be used to provide ground support within which the overflow weir chamber walls 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 water to the River Thames after being treated through a settlement system.

3.3.47 To enable this to be constructed the westbound ramp leading down from Blackfriars Bridge would be closed, partially removed and reinstated on completion. Existing telecommunications cables located in the footpath and carriageway in the ramp would be protected and diverted where necessary.

3.3.48 The walls of the overflow weir chamber would be formed by in-situ reinforced concrete techniques. Concrete would be delivered to site and either pumped or skipped to the chamber. The piled walls would be extended to the CSO drop shaft to allow the connection culvert to be constructed in a similar manner to the chambers.

3.3.49 It is assumed that piles would be used to support the underground chambers, and would be bored reinforced concrete piles. The diameter, depth and spacing would depend on the structure design and ground conditions.

3.3.50 The existing Fleet outfall to the River Thames would be intercepted within the new foreshore structure and flow through a valve chamber before entering the drop shaft. These chambers would be constructed using similar methods to the overflow weir chamber. A new outfall would be constructed on the front of the new river wall to cater for the event that the main tunnel cannot accept any more flow. Flap valves would be fitted to prevent tidal flow entering the system.

3.3.51 Air management structures comprising a below ground passive filter chamber and associated ducts and ventilation columns and the electrical and control kiosks would also be built and commissioned.

Completion of works and site restoration

3.3.52 On completion of the main construction (outlined above) the new river wall would be finished prior to removal of the temporary cofferdam to ensure flood protection.

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

3.3.54 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 cofferdam.

3.3.55 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.

3.3.56 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 wall would be completed prior to removal of the temporary cofferdam.

Excavated materials and waste

3.3.57 The construction activities described above and in particular the construction of the drop shaft would generate a large volume of excavated material which would require removal. This is estimated at 160,000 tonnes, the main elements of which would comprise approximately 87,000 tonnes of imported fill (which would require later removal), 14,000 tonnes of mixed materials from the diaphragm wall construction, 1,000 tonnes of made ground, 34,000 tonnes of London Clay, 21,000 tonnes of Lambeth group and 3,000 tonnes of Thanet group.

3.3.58 In addition, it is estimated that approximately 6,000 tonnes of construction waste would be generated including 4,000 tonnes of imported fill and 2,000 tonnes of concrete.

3.3.59 Excavated materials and construction wastes would be exported from the site in accordance with the *Transport Strategy* which accompanies the application for development consent (the 'application') (see Access and movement below).

Access and movement

3.3.60 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’.

3.3.61 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. In addition, 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.

3.3.62 The highest barge movements (peak barge movements) would occur during removal of the temporary cofferdam. Peak daily barge numbers, averaged over a one month period, would be three barges per day, equivalent to six barge movements. It is estimated that total barge numbers for this site would be 369, equivalent to 738 barge movements over the construction period. Barge numbers are based upon an assessed barge size of 800T. It is estimated that tugs would be present at this site for approximately 20 minutes when delivering / collecting barges.

3.3.63 The highest lorry movements (peak vehicle movements) at the site would occur during shaft construction. The peak daily vehicle numbers at this time, averaged over a one month period, are estimated to be 46 HGV lorries, equivalent to 92 movements per day. It is estimated that total vehicle numbers for this site would be in the order of 13,400 HGV lorries, equivalent to 26,700 movements over the construction period.

3.3.64 The site access point would be via a left turn into the site from the westbound ramp leading down from Blackfriars Bridge during most phases of construction. When the overflow weir chamber is being constructed (and therefore the ramp is closed), access would be via a left turn into the site from Victoria Embankment (Blackfriars Underpass). Egress would be a left turn back out onto Victoria Embankment.

3.3.65 The Thames Path running along the river embankment would be temporarily diverted along Blackfriars Bridge Road and Victoria Embankment. Appropriate diversion signage would be deployed.

3.3.66 A *Traffic management plan* would be developed for the site, produced, coordinated and implemented by the contractor. This is a requirement of the *CoCP*.

3.3.67 A *Draft Project Framework Travel Plan*, which accompanies the application for development consent (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 developed the project would divert the majority of current CSO discharges via the CSO drop shaft to the main tunnel for conveyance and treatment at Beckton Sewage Treatment Works (STW). The number of CSO discharges would be reduced from 21 spill events in a typical year to approximately four times in a typical year at an average rate of approximately 37,000m^3 per year.

3.4.5 It would, additionally, provide control to the northern Low Level Sewer No.1. The connection to the northern Low Level Sewer No. 1 at this site and at two other sites (Chelsea Embankment Foreshore and Victoria Embankment Foreshore) controls the discharge from ten CSOs along the northern embankment.

Operational structures

3.4.6 For the purposes of the application, each of the main operational 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 (see separate volume of figures – Section 1).

3.4.7 The heights of the main ventilation columns and the dimensions of other above and below ground structures 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 and other structures where this is considered helpful to the reader.

3.4.8 The assessment for each of the environmental topics has been based on the most appropriate 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 been assessed. The approach that has been adopted in this regard is explained within each topic assessment section, where necessary.

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

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

Shaft

3.4.11 The location, diameter and depth of the drop shaft are described in Section 3.2. The drop shaft would be finished to the existing embankment level. A parapet wall would extend approximately 1m above this at the east of the site and a raised paved area with balustrade extending approximately an additional 1.25m above the existing embankment level at the west of the site.

3.4.12 There would be covers on top of the shaft to allow access and inspection.

Chambers and culverts

3.4.13 The interception chamber, overflow weir chamber, culverts, valve chambers and overflow chamber would be below ground. There would be covers on top of the chambers to allow access and inspection.

River wall

3.4.14 The location of the new river wall/balustrade is defined in Section 3.2. An open balustrade would be constructed along the western and south western edge of the new foreshore structure which is finished above flood defence level. A solid wall finished above flood defence level would be constructed around the south eastern edge of the foreshore structure which is finished below flood defence level.

Air management structures

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

3.4.16 In addition to these structures, an underground air treatment chamber would contain an air management filter and would be connected to the ventilation columns. The air treatment chamber would have ground level covers to allow access and inspection.

Electrical and control kiosk

3.4.17 The height and location of the above ground electrical and control kiosk is defined in Section 3.2.

Permanent restoration and landscaping

3.4.18 The Proposed site features plan is presented in a separate volume of figures (Section 1). The final landscape and restoration proposals would be subject to both the generic and site specific design principles (see Section 3.2).

3.4.19 As shown on the proposed site features plan, Blackfriars Millennium Pier would be relocated to a permanent position east of Blackfriars Rail Bridge and replaced with equivalent facilities. The vessel President would be moved back to its original location. Access ramps to the relocated moorings for the President would be designed to current standards. They would either bridge over the river wall with minimum physical or visual impact on the listed structure or they would span from the elevated platform at the western end of the foreshore structure.

3.4.20 The lift installed to provide access to Blackfriars Road Bridge prior to the construction works would remain in situ post construction.

3.4.21 The operational structure at the site would be constructed within the reclaimed foreshore area behind the new river wall. There would be a new paved surface mainly at existing embankment level with areas at a higher level at the western end of the site (to create a viewing platform) and to the northeast where the site adjoins the westbound ramp from the bridge.

3.4.22 The area above the structures would be finished with hardstanding to allow maintenance vehicle and crane access to the covers on top of the shaft. This hardstanding would form an extension to the Thames Path and would usually be publicly accessible. However, Thames Water would retain a right of access over it and would install temporary security fencing on parts of it when the area is used for shaft access.

3.4.23 Access to the Blackfriars Bridge Foreshore site would be via a new vehicular access from the westbound ramp leading down from Blackfriars Bridge at the western end of the foreshore structure. This would be constructed at the foot of the down ramp from Blackfriars Bridge and would be accessed from the ramp. The existing coach parking on Victoria Embankment would be reinstated.

3.4.24 The site would be accessible to the public by foot. A riverside walk would be created over the new foreshore structure.

3.4.25 The landscape design would seek to encourage biodiversity and planting and would respect the setting of the listed Blackfriars Bridge. Trees planted on the existing embankment would be semi-mature London Planes. The foreshore structure would be planted with additional smaller trees to provide shade and improve microclimate.

3.4.26 The foreshore structure walls would be finished in natural stone. The Lions Heads on the river would be incorporated into the design where possible.

3.4.27 A water feature to encourage play and improve microclimate would be incorporated into the design.

3.4.28 New lighting to the foreshore structure would be provided. The festoon lighting to Victoria Embankment would be reinstated as far as possible. The sturgeon lamp stands would be carefully removed, stored and reinstated in their current position as far as possible. The existing "replica" lamp stands would be replaced with originals from elsewhere (by agreement) or new castings from the original moulds if possible.

Typical maintenance regime

3.4.29 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. Additionally, once every ten years, more significant maintenance work would be carried out. 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 18 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 Blackfriars Bridge Foreshore are listed below. A map showing their location is included in Vol 18 Figure 3.5.1. (see separate volume of figures).

a. Puddle Dock Mermaid Theatre
b. 1-16 Blackfriars Road
c. 231-241 Blackfriars Road
d. Bankside 4, Holland Street
e. Tate Modern
f. 20 Blackfriars Road
g. Wedge House, 32-40 Blackfriars Road
h. 30 Old Bailey
i. Land bounded by Upper Ground and Doon St (adjacent to Cornwall Rd)
j. Elizabeth House
k. London Eye Pier 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 18 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 18 Table 3.6.1 Blackfriars Bridge Foreshore – on-site alternatives

Item	Alternatives considered	Reason not progressed
Relocation of Blackfriars Millennium Pier	Temporary relocation of Blackfriars Millennium Pier	• Due to the scale of the foreshore structure, the Pier would be in the navigation channel if returned to its original location.
Location of foreshore structure	A location slightly further downstream, in closer proximity to Blackfriars Bridge	• To increase the distance between and reduce effects on the Waterloo and City line London Underground infrastructure and river flows under Blackfriars Bridge.
Lifts to the east of Blackfriars Bridge	Installation of temporary lifts to the east of Blackfriars Bridge	• To improve step-free access between the relocated pier and Blackfriars Station in the operational case the lift would be permanent.
Ventilation structures	Construction of a ventilation building	• Changes to the project-wide air management strategy means a ventilation building would not be required at this site and therefore the size of the ventilation structures could be reduced.
Low Level Sewer overflow weir location	Location to the west of the shaft	• Current location has lower impact upon highway and utilities in subway

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.18**

Volume 18 Blackfriars Bridge Foreshore site assessment

Section 4: Air quality and odour

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 18: Blackfriars Bridge 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 Blackfriars Bridge Foreshore site. The assessment covers the effects associated with both the main site and Blackfriars Pier site. 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. temporary closure of lanes during construction, which can lead to an increase in vehicle emissions through worsened congestion or through vehicles being routed onto other roads (air quality)

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

d. emissions from construction plant (air quality)

e. construction-generated dust (air quality)

f. 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 Blackfriars Bridge Foreshore site comprises four separate components: effects on local air quality from construction road traffic (taking account of temporary lane closures); 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 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 18

Blackfriars Bridge Foreshore figures). Appendices supporting this site assessment are contained in Vol 18 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 Blackfriars Bridge Foreshore site would occur during the shaft construction (commencing Site Year 2 of construction). The average daily number of vehicle movements during the peak month would be approximately 92 movements per day.

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

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 highest number of barge movements in any one year would be four barge movements a day averaged over a one month period in Site Year 1 of construction. The emissions associated with the tugs pulling the barges are presented in Vol 18 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 Blackfriars Bridge Foreshore site in the peak construction year and associated emissions data are presented in Vol 18 Appendix B.4.

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

Construction dust

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

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 Blackfriars Bridge Foreshore site there would be approximately 650m^3 of demolition material generated while the amount of amount of material moved during the earthworks would be approximately 309,000 tonnes. The volume of building material used during construction would be approximately 35,000m^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* (Section 7) in accordance with the London Councils Best Practice Guidance (GLA, 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 Blackfriars Bridge Foreshore site.

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

4.2.15 There are no site-specific air quality measures contained in the *CoCP* Part B.

Operation

4.2.16 The ventilation structure would treat air released from the tunnel. The air would be treated by passing air through five 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 2m^3/s. The maximum air release rate from each filter during a typical year is expected to be about 1.5m^3/s, therefore all air in a typical year would be treated through the passive filter. No nuisance odours are therefore expected.

4.2.17 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.

[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).

Environmental design measures

4.2.18 A carbon filter would be included as part of the ventilation structure 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*.

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 18 Table 4.3.1).

Vol 18 Table 4.3.1 Air quality and odour – stakeholder engagement

Organisation	Comment	Response
City of London Corporation, scoping response, May 2011	The odour impact beyond the immediate vicinity of the site at Blackfriars should be considered. Of particular concern is the impact during operation of the odours emanating from other parts of the sewer network. Ideally the EIA scoping should include investigation of mitigation for existing sewer related odours or at the very least provide evidence that such odours will not be worsen during the operation of the Thames Tideway Tunnel.	Odour modelling has been carried out for an area of around 250m from the vent at a resolution of 5m. It is not expected that odours from existing sewers would worsen with the Tunnel, because the operation of the Tunnel is designed to stop the overflows going into the Thames, not to alter the operation of the sewers.
City of London Corporation (February 2011)	Agree monitoring locations with City of London Corporation.	Locations agreed with City of London Corporation Environmental Policy Officer.
City of London Corporation (June 2011 and July 2012)	Odour complaints in the area should be considered	No odour complaints made to City of London Corporation near Blackfriars Bridge Foreshore site in recent years; confirmed by City of London Corporation Technical Officer.
City of London Corporation, Position Paper, February 2011	Assess the potential for construction traffic to lead to an exceedance of the PM_{10} 24 hour AQO along Upper / Lower Thames St and Victoria	Dispersion modelling has been used to assess the potential impacts of the construction phase for the relevant short- and long-term NO_2 and PM_{10}

Organisation	Comment	Response
	Embankment. May require extra controls over emissions of PM_{10} from construction vehicles here (ie, latest Euro standards for HGVs and LGVs). All non-road mobile machinery should meet Stage IIIA emissions criteria.	air quality objectives / limit values. In line with the predicted impacts of the construction phase from both road traffic and on-site activities, proportional mitigation is applied if appropriate. It should be noted that a *CoCP (Parts A and B)* has been drawn up for the project in consultation with all relevant local authorities. All NRMM would meet the criteria set out in the Non-Road Mobile Machinery (Emission of Gaseous and Particulate Pollutants) (Amendment) Regulations 2006.
City of London Corporation, Position Paper, February 2011	Odour – concern over smell nuisance escaping from the works and the possibilities of increased smell/odour loads on City sewers from the works on the TWU trunk sewers. Sewer vents need to be installed in locations where odours will not be a further problem. New trunk sewers would most likely have an impact on our low level vents in the roads as these are the current positions for TWU trunk sewer to vent.	The proposed vent sites were selected after careful consideration of a wide range of factors such as the location of the CSOs, tunnel engineering factors, land availability, access to the site for construction, sensitivity of land use and size of site. The Tunnel is not expected to affect discharges from existing vents. The control of potential odours during the construction works are dealt with in *CoCP Part A*.
City of London Corporation, Position Paper, February 2011	There is little to be gained by monitoring NO_2 using diffusion tubes for 6 months. These are notoriously unreliable and a minimum of 12 months is normally required to draw any meaningful conclusions about the baseline - even then they are not very reliable.	Whilst accepting their technical limitations, diffusion tubes are an accepted monitoring method for NO_2, according to the Defra air quality guidance LAQM.TG(09)[2] and have proved a worthwhile indicator in association with continuous monitoring. 12 months of monitoring data have been collected for the baseline assessment.
City of London Corporation,	We would be interested in commenting on any	Details of the emissions mitigation for both the

Organisation	Comment	Response
Position Paper, February 2011	methodology for controlling emissions	construction and operational phases of the development are provided in *CoCP Part A* and the Air management plan. Consultation on both plans has been undertaken with all relevant local authorities.
City of London Corporation, Phase two Consultation, January 2012	River transport should be the preferred option wherever practical in order to avoid disruption to the congested central London road network. The use of river transport would also reduce carbon emissions associated with materials transport and avoid exacerbation of the poor air quality which exists on the main road routes through this area. The preliminary environmental report predicts that the impacts on emissions are expected to be small due to the low number of additional lorries during construction in the context of existing traffic flows on the local road network. This assertion has been strongly disputed during discussions and it is intended to continue to put the case that the majority of materials and equipment be transported by river.	River transport has been maximised, , where practicable and cost effective, in order to minimise the effects on local air quality in the vicinity of Blackfriars Bridge Foreshore site. At the Blackfriars Bridge Foreshore site it is proposed that 90% cofferdam fill material will be transported in and out by barge along with 90% of shaft and other excavated material.
City of London Corporation, Phase two Consultation, January 2012	The consultation indicates that demolition and construction would be carried out in accordance with an agreed Code of Practice. The City would require that the requirements of the City of London Code of Practice for Construction and Deconstruction should apply. Full demolition and construction method statements would be required and it would be acceptable that the works be carried out under Section 60 of the Control of Pollution Act 1989.	The *CoCP* covers these requirements.

Organisation	Comment	Response
City of London Corporation, Phase two Consultation, January 2012	The City of London Air Quality Strategy 2011 - 2015 shows that Victoria Embankment and the Blackfriars Underpass adjacent to this site suffer from some of the worst air quality in the City with particulates (PM_{10}) and nitrogen dioxide being of particular concern. In this area pollution levels fail to meet the European limit values for PM_{10} and nitrogen dioxide therefore it is essential that this issue is not exacerbated during construction or operational phases of this development. To this end, maximum use should be made of river transport in order to reduce the impact of lorry movements on air quality. Additionally during the construction phase construction dust must be kept to a minimum. Paragraph 4.5.24 of the Preliminary environmental information report states that "the likely significance of the construction dust effects is deemed to be a moderate adverse effect." Mitigation and monitoring must be implemented to demonstrate that this development positively addresses the issue of poor air quality at this location.	River transport has been maximised, , where practicable and cost effective, in order to minimise the effects on local air quality in the vicinity of Blackfriars Bridge Foreshore site. The construction phase assessment for the Blackfriars Bridge Foreshore site indicates a moderate adverse effect without the *CoCP* measures. The implementation of the *CoCP* measures would reduce the significance of the effects of construction dust to negligible. As detailed in para. 4.8.3, a monitoring regime would be discussed with the City of London Corporation prior to its implementation.
City of London Corporation, Section 48 Response, October 2012	It is important that the proposal does not result in nuisance in the form of smells and odours. Air modelling of the ventilation odour outlets would need to be carried out to ensure any possible smells are contained at source or if allowed to ventilate to the surrounding area that, this occurs without creating a nuisance.	Dispersion modelling has been carried out to assess the impact of emissions from all of the ventilation sites. At the Blackfriars Bridge Foreshore site, the maximum number of hours with a potentially detectable odour (> $1.5ou_E/m^3$) at ground level is seven. This is well within the odour benchmark of $1.5ou_E/m^3$ which can be exceeded for 175 hours in a year. The Thames

Organisation	Comment	Response
		Tideway Tunnel is isolated from the existing sewerage network serving the City of London by flap valves. Thus there is no effect on the current air balance in the existing sewers. When the tunnel is not capturing combined wastewater, the flap valves are closed and tunnel air cannot enter the existing sewers. When the tunnel is capturing combined wastewater, the flap valves would be forced open by the flow of wastewater. Some air may be dragged into the tunnel from the sewerage network along with the wastewater, but no air would escape from the tunnel into the sewerage network.
City of London Corporation, Section 48 Response, October 2012	Further information and the proposed methods of odour control would be required in order to confirm that the proposed forced air systems would not have a detrimental effect (causing negative or positive pressures) on the existing, natural ventilating sewer vents. Most City sewers vent at low level in the public highways. The area around Blackfriars has suffered odour smells from the existing sewer vents and any imbalances in the system could exacerbate this problem.	The ventilation columns at the Blackfriars Bridge Foreshore site would be at 4-8m height so would be above nose height. The tunnel would be at slight negative pressure to reduce air releases.
City of London Corporation, Section 48 Response, October 2012	The proposed Thames Tideway Tunnel project would support the following aims of the City of London's Community Strategy: • To continue to minimise noise, land and water pollution and improve air quality where this is possible	The movement of materials by river would minimise the local air quality effects from road transport. Measures in the CoCP have been included to minimise pollutant emissions to air.

Baseline

4.3.2 The baseline methodology follows the methodology described in Volume 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 Volume 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 Blackfriars Bridge Foreshore site. There are no other Thames Tideway Tunnel sites which could elevate construction dust nuisance effects within the assessment area (see para. 4.3.5). Also, it is noted that when assessing construction dust at the Blackfriars Bridge Foreshore site, the effect of the two parts of the site (main site and Blackfriars Pier) have been considered in combination to ensure a robust assessment. With regard to local air quality, the effect of all relevant traffic associated with Thames Tideway Tunnel 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 Blackfriars Bridge Foreshore main 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 Blackfriars Bridge Foreshore site are fully assessed. A distance of 200m is generally considered sufficient[3] 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 2 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 Thames Tideway Tunnel project) has been assessed against the base case (without Thames Tideway Tunnel project) to identify likely significant effects of the Thames Tideway Tunnel project.

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 18 Appendix N), there are two other new developments (Puddle Dock Mermaid Theatre and 1-16 Blackfriars Road) identified within the construction assessment area, both of which are relevant to the air quality assessment being sensitive properties in close proximity to the site.

4.3.9 As both the developments would be complete and operational by Site Year 2 of construction, there are no cumulative construction effects to assess.

Operation

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

4.3.11 Section 4.6 details the likely significant effects arising from the operation at the Blackfriars Bridge Foreshore site. There are no other Thames Tideway Tunnel sites which could give rise to additional effects on odour within the assessment area for this site, and therefore no other Thames Tideway Tunnel sites are considered in this assessment.

Operational assessment area

4.3.12 Odour dispersion modelling has been carried out over an area of 450m by 550m centred on the Blackfriars Bridge Foreshore main 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

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

Other developments

4.3.14 Regarding other new developments, there are two new developments set out in the site development schedule (see Vol 18 Appendix N) that are within the odour assessment area (Puddle Dock Mermaid Theatre and 1-16 Blackfriars Road) and are relevant to the odour assessment representing additional receptors requiring consideration. Due to the nature of the developments there are however no cumulative operational odour effects to assess.

Assumptions and limitations

Assumptions

4.3.15 The general assumptions associated with this assessment are presented in Volume 2.

Construction

4.3.16 The site specific assumptions in terms of model input are set out in Vol 18 Appendix B.

Operation

4.3.17 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. 4.2.16 to 4.2.18.

4.3.18 Odour dispersion modelling only includes emissions from the ventilation structure 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 have been no complaints 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[4].

4.3.19 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

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

Construction

4.3.21 As there are no PM_{10} monitoring sites located close to the Blackfriars Bridge Foreshore site, it has not been possible to verify PM_{10} modelling results[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.

Operation

4.3.22 There are no 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.

[iii] Model verification refers to checks that are carried out on model performance at a local level. This 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.

4.4.3 As part of their duties under Part IV of the Environment Act 1995 (UK Government)[5], 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 are four continuous monitoring stations and three diffusion tubes operated by City of London Corporation which collect data pertinent to the Blackfriars Bridge Foreshore site and associated construction traffic routes. The location of these is shown in Vol 18 Figure 4.4.1 (see separate volume of figures). Monitoring data for these sites for the period 2007-2011 are contained in Vol 18 Table 4.4.1 (NO_2 concentrations) and Vol 18 Table 4.4.2 (PM_{10} concentrations).

Vol 18 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 sites											
Senator House (CT1)	Urban background	**51**	**51**	**48**	**49**	**48**	0	2	0	0	2
Sir John Cass School (CT3)	Urban background	**45***	**55**	**56**	**55**	**54**	0 (119)*	3	2	0	0
Walbrook Wharf (CT6)	Roadside	**103****	**117**	**131**	**128**	NM	**233**	**636**	**951**	**866**	NM
Beech Street (CT4)	Roadside	NM	NM	**90**	**85**	**90**	NM	NM	**189**	**106**	**302**
Diffusion tube monitoring sites											
Queen Victoria Street (CL38)	Roadside	**63**	**63**	**67**	**75**	**69**	NM				
St Dunstans, Fleet Street (CL39)	Roadside	**97**	**90**	**102**	**82**	**108**	NM				
St Bartholomew's Hospital (CL05)	Urban centre	**45**	**44**	**43**	**43**	**50**	NM				

*Note: NM indicates not measured. 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 18 Figure 4.4.1 (see separate volume of figures). * Data capture of 87%, the figure in brackets for the hourly exceedances is the 99.8th percentile. ** Data capture of 74%.*

Vol 18 Table 4.4.2 Air quality – measured PM_{10} concentrations

Monitoring site	Site type	Annual mean (µg/m³)					Number of exceedances of daily standard				
		2011	**2010**	**2009**	**2008**	**2007**	**2011**	**2010**	**2009**	**2008**	**2007**
Upper Thames Street (CT8)	Roadside	37	37	36	32	NM	**48**	**55**	**44**	**37**	NM
Sir John Cass School (CT3)	Urban background	28	26*	27	26	31**	22	9 (40)*	11	15	31 (48)**
Beech Street (CT4)	Roadside	NM	NM	28	26	34	NM	NM	23	20	**60**

*Note: * Data capture of 85%. Figure in brackets represents the 90th percentile.** Data capture of 81%. Figure in brackets represents the 90th percentile. NM indicates not measured. N/A indicates not available. Emboldened figures indicate an exceedance of the objective which is 40µg/m³ for the annual mean and 50µg/m³ for the daily mean which can be exceeded 35 times per year. Codes in brackets represent monitoring site identifiers used in Vol 18 Figure 4.4.1 (see separate volume of figures).*

4.4.5 The NO_2 monitoring indicates that all seven sites measured exceedances of the annual mean objective / limit value (40µg/m^3) and two of the four continuous monitoring sites (Walbrook Wharf and Beech Street – both roadside sites) measured exceedances of the hourly objective over recent years.

4.4.6 The PM_{10} monitoring indicates that none of the three sites have measured exceedances of the annual mean objective / limit value (40µg/m^3) over recent years. However, two of the three sites have shown an exceedance of the PM_{10} daily standard.

4.4.7 The City of London Corporation has declared the whole borough an Air Quality Management Area (AQMA) for NO_2 and PM_{10}.

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 Blackfriars Bridge Foreshore site. This monitoring comprises four diffusion tubes based at the locations identified in Vol 18 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%. a triplicate site (comprising three diffusion tubes) was established at a continuous monitoring site in Putney (site PEFM4 – see Vol 7); for additional precision, a triplicate site was established at one of the monitoring sites (BBFM4) near the Blackfriars Bridge Foreshore site; otherwise all the monitoring locations have single tubes.

Vol 18 Table 4.4.3 Air quality – additional monitoring locations

Monitoring site	Grid reference	Site type	2010 NO_2 annual mean (µg/m^3)
A201 Blackfriars Bridge (BBFM1)	531667, 180488	Roadside	**74.6**
A3211 Victoria Embankment (BBFM2)	531398, 180840	Roadside	**93.1**
A201 New Bridge Street 2 (BBFM3)	531658, 181056	Roadside	**95.1**
A201 New Bridge Street 1 (BBFM4)	531631, 181282	Roadside	**95.4**

Note: Emboldened figures indicate an exceedance of the objective / limit value which is 40µg/m^3 for the annual mean.

4.4.9 All four sites recorded concentrations above the NO_2 annual mean standard of (40µg/m^3). 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 City of London Corporation 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[6]. 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 Blackfriars Bridge Foreshore site are given in Vol 18 Table 4.4.4 for 2010 (baseline year).

Vol 18 Table 4.4.4 Air quality – 2010 background pollutant concentrations

Pollutant*	2010
NO_2 (µg/m^3)	56.7
PM_{10} (µg/m^3)	24.4

** Annual mean for 1km grid square centred on 531500, 180500.*

Odour

4.4.12 The City of London Corporation has not received any odour complaints for the local area over recent years[7]. Complaints in the Thames Water database were reviewed within an area of 500m radius of the zones identified for the proposed ventilation columns. Only three complaints were identified since 2005, one relating to odour from the local sewage pumping station in 2009, and the other two in 2010 and 2011, relating 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 18 Table 4.4.5 and the monitoring locations shown in Vol 18 Figure 4.4.2 (see separate volume of figures).. The highest concentrations, up to 33.3µg/m^3, were measured on 28 February 2012 during westerly winds. These levels are typical of urban areas4 when a faint odour may be detectable on occasions and concentrations can be raised occasionally (World Health Organisation, 2000)[8] [iv].

Vol 18 Table 4.4.5 Odour – measured H_2S concentrations

Location	Grid reference	Date	Time	H_2S concentration (µg/m^3)
Temple Avenue /	531396, 180809	28/08/11	09:03:57	0.0
		28/08/11	09:04:42	0.0

[iv] 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 ($\mu g/m^3$)
The President (BBFS1)		30/10/11	09:31:36	7.7
		30/10/11	09:32:06	5.7
		01/12/11	14:00:56	33.1
		01/12/11	14:02:26	10.6
		22/02/12	09:07:14	31.9
		22/02/12	09:08:29	10.3
		28/02/12	13:49:17	33.3
		28/02/12	13:50:53	9.6
		21/05/12	08:50:32	10.6
		21/05/12	08:51:33	8.6
Carmelite Street (BBFS2)	531466, 180809	28/08/11	09:05:37	0.0
		28/08/11	09:06:07	0.0
		30/10/11	09:32:49	5.4
		30/10/11	09:33:17	5.0
		01/12/11	14:03:27	11.2
		01/12/11	14:04:39	15.7
		22/02/12	09:09:46	9.1
		22/02/12	09:10:46	10.0
		28/02/12	13:51:55	8.2
		28/02/12	13:53:02	8.8
		21/05/12	08:52:28	9.1
		21/05/12	08:53:23	8.6
John Carpenter Street (BBFS3)	531512, 180811	28/08/11	09:07:17	0.0
		28/08/11	09:07:47	0.0
		30/10/11	09:34:06	4.7
		30/10/11	09:34:33	0.0
		01/12/11	14:06:34	32.8
		01/12/11	14:07:29	21.5
		22/02/12	09:11:53	8.8
		22/02/12	09:12:54	8.4
		28/02/12	13:54:10	6.9
		28/02/12	13:55:24	6.6

Location	Grid reference	Date	Time	H_2S concentration (µg/m^3)
		21/05/12	08:54:34	8.7
		21/05/12	08:55:29	7.9
Blackfriars Millennium Pier (BBFS4)	531556, 180816	28/08/11	09:09:56	0.0
		28/08/11	09:10:25	0.0
		30/10/11	09:35:26	7.2
		30/10/11	09:35:54	4.7
		01/12/11	14:08:35	9.1
		01/12/11	14:09:30	6.4
		22/02/12	09:14:19	8.6
		22/02/12	09:15:19	8.8
		28/02/12	13:56:32	6.4
		28/02/12	13:57:45	6.4
		21/05/12	08:56:45	9.6
		21/05/12	08:57:45	7.8
By bridge (BBFS5)	531595, 180813	28/08/11	09:11:40	0.0
		28/08/11	09:12:10	0.0
		30/10/11	09:36:57	0.0
		30/10/11	09:37:27	0.0
		01/12/11	14:10:46	7.0
		01/12/11	14:11:42	6.3
		22/02/12	09:16:30	6.6
		22/02/12	09:17:34	7.2
		28/02/12	13:58:52	5.9
		28/02/12	14:00:10	7.5
		21/05/12	08:58:59	8.3
		21/05/12	09:00:00	7.8
Meteorological conditions: 28/08/11 SW calm wind, partially cloudy, rain on previous day. 30/10/11 SW wind at 0.5m/s, cloudy, last rain on 27/10/11. 01/12/11 calm, wind speed up to 1m/s, cloudy and dry. 22/02/12 W wind up to 10.1m/s, partially cloudy. 28/02/12 W wind up to 3m/s, cloudy. 21/05/12 W wind, average speed 1.2m/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 18 Figure 4.4.3 (see separate volume of figures) and the table below (Vol 18 Table 4.4.6) for the Blackfriars Bridge 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 Volume 2.

4.4.15 It is noted that Vol 18 Table 4.4.6 includes two receptors associated with new developments at the Puddle Dock Mermaid Theatre and 1-16 Blackfriars Road (see site development schedule in Vol 18 Appendix N) for consideration in the air quality and odour assessments.

Vol 18 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 - Upper floors of Kings Bench Walk (BBFR1)	60m north of main site	High (exposure relevant to annual mean, daily mean and hourly mean standards).	Medium	High
Residential - River Court, south bank of the river (BBFR14)	240m south of main site	High (exposure relevant to annual mean, daily mean and hourly mean standards).	Medium	High
Residential - 1-16 Blackfriars Road (BBFR13)*	260m south of main site	High (exposure relevant to annual mean, daily mean and hourly mean standards).	Medium	High
Residential - Globe View, High Timber Street (BBFR12)	300m east of main site	High (exposure relevant to annual mean, daily mean and hourly mean standards).	Medium	High
Educational - City of London School building (BBFR10)	50m east of Blackfriars Pier site	High (exposure relevant to annual mean, daily mean and hourly mean standards).	Medium	High
Educational - St Paul's Choir School building (BBFR11)	390m northeast of Blackfriars Pier site	High (exposure relevant to annual mean, daily mean and hourly mean standards).	Medium	High
Hotel - Crown Plaza Hotel (BBFR6)	120m north of main site	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)
Public House - Blackfriars PH, Queen Victoria Street (BBFR7)	140m north of main site	Medium (exposure relevant to daily mean and hourly mean standards).	Medium	High
Commercial – 1 Temple Avenue (BBFR20)	25m north of main site	Low (exposure is relevant for the hourly mean standard only).	Medium	Medium
Commercial - Sion Hall (BBFR3)	25m north of main site	Low (exposure is relevant for the hourly mean standard only).	Medium	Medium
Commercial/retail - 60 Victoria Embankment (BBFR4)	25m north of main site	Low (exposure is relevant for the hourly mean standard only).	Medium	Medium
Commercial/retail - 100 Victoria Embankment (BBFR5)	25m north of main site	Low (exposure is relevant for the hourly mean standard only).	Medium	Medium
Restaurant –President vessel (BBFR15/19)*	20m west of main site in temporary location	Low (exposure is relevant for the hourly mean standard only).	Low	High
Recreational -Thames Path (BBFR16)	Adjacent to main site	Low (exposure is relevant for the hourly mean standard only).	Medium	Low
Recreational - River Thames (BBFR17)	Adjacent to main site	Low (exposure is relevant for the hourly mean standard only).	Low	Low
Recreational - Inner Temple Gardens (BBFR2)	25m north of main site	Medium (exposure relevant to the hourly mean standard only).	Medium	Medium

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)
Recreational - Puddle Dock Mermaid Theatre (BBFR8)*	100m northeast of Blackfriars Pier site	Medium (exposure relevant to daily mean and hourly mean standards).	Medium	Medium
Other - Blackfriars Station (BBFR18)	10m east of main site	Low (exposure is relevant for the hourly mean standard only).	Medium	Medium
Other - Mermaid Conference Centre (BBFR9)	30m north of Blackfriars Pier site	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)[9] 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)[10]. Background pollutant concentrations for Site Year 2 of construction (peak construction year) used in the modelling are shown in Vol 18 Table 4.4.7.

4.4.19 The background NO_2 concentration has been taken from local monitoring data. The background PM_{10} concentration has been taken from the Defra mapped background data6 as there are no relevant monitoring sites in the vicinity of the site. The PM_{10} background concentrations shown have been adjusted to remove the local road contribution, as these road sources are being modelled as part of the assessment.

Vol 18 Table 4.4.7 Air quality – annual mean background pollutant concentrations

Pollutant	Baseline (2010)	Peak construction year (Site Year 2 of construction)
NO_2 (µg/m^3)*	43.8	35.3
PM_{10} (µg/m^3)**	23.9	21.8

** Derived from CL05 2010 monitoring. ** Taken from Defra mapped 1km grid square centred on 531500, 180500. Adjusted to ensure local A roads are not double-counted.*

4.4.20 As indicated in para. 4.4.15, the base case in Site Year 1 of construction takes into account new developments at the Puddle Dock Mermaid Theatre and 1-16 Blackfriars Road, including them as receptor locations in the air quality assessment. These are included in the receptor list provided in Vol 18 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. 4.4.15, the base case for the odour assessment takes into account the Puddle Dock Mermaid Theatre and 1-16 Blackfriars Road, including them as receptor locations in the odour assessment. These are included in the receptor list provided in Vol 18 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 Volume 2. This involves predicting NO_2 and PM_{10} concentrations in the baseline year (2010) and in the peak construction year (Site Year 2 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 18 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 Blackfriars Bridge Foreshore site in line with the Defra guidance LAQM.TG(09)2. This checks the model performance against measured concentrations, using the four monitoring sites established for this assessment (BBFM1 – BBFM4 – see Vol 18 Table 4.4.3). Further details regarding the verification process are included in Vol 18 Appendix B.1. The model adjustment factor derived from the verification process was applied to all model results.

4.5.4 The model inputs for the local air quality assessment for the Blackfriars Bridge Foreshore site are also detailed in Vol 18 Appendix B (B.2, B.3 and B.4). 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 18 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

18 Figures 4.5.1 – Vol 18 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 18 Figure 4.5.4 (see separate volume of figures).

4.5.6 The modelled concentrations in Vol 18 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 small increases or no change over the base case at all modelled receptors due to the construction, except at the President (BBFR15/19).

4.5.7 Exceedances of the annual mean objective / limit value (40µg/m^3) are predicted for all receptors in all scenarios. In the base and development cases, 16 receptors are predicted to have annual mean concentrations above 60µg/m^3 so in line with LAQM.TG(09), exceedences of the hourly NO_2 air quality objective/ limit value are considered likely in both the base and development cases at these receptors.

Vol 18 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					
King's Bench Walk residential (BBFR1)	**68.7**	**56.2**	**56.3**	0.2	Negligible
River Court residential (BBFR14)	**75.2**	**62.7**	**62.8**	0.0	Negligible
1-16 Blackfriars Road residential (BBFR13)*	**79.1**	**66.7**	**66.7**	0.0	Negligible
Globe View, High Timber Street residential (BBFR12)	**73.8**	**59.4**	**59.5**	0.1	Negligible
City of London School building	**92.5**	**75.5**	**75.5**	0.0	Negligible

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		
(BBFR10)					
St Paul's Choir School building (BBFR11)	**52.3**	**41.6**	**41.6**	0.0	Negligible
Receptors where the annual mean objective / limit value does not apply					
Crown Plaza Hotel (BBFR6)	**105.7**	**91.5**	**91.6**	0.0	Negligible
Blackfriars PH (BBFR7)	**109.6**	**94.9**	**95.0**	0.1	Negligible
1 Temple Avenue (BBFR20)	**85.8**	**71.9**	**72.2**	0.3	Negligible
Sion Hall (BBFR3)	**82.4**	**67.5**	**67.8**	0.3	Negligible
60 Victoria Embankment (BBFR4)	**88.8**	**72.8**	**73.1**	0.3	Negligible
100 Victoria Embankment (BBFR5)	**83.0**	**69.2**	**69.3**	0.1	Negligible
President (BBFR15/19)*	**98.7**	**83.7**	**74.5***	-9.3	Large
Thames Path (BBFR16)	**134.7**	**115.7**	**116.7**	1.0	Small
River Thames (BBFR17)	**66.8**	**54.1**	**54.7**	0.6	Small
Inner Temple Gardens (BBFR2)	**89.9**	**76.0**	**76.4**	0.5	Small
Puddle Dock Mermaid Theatre (BBFR8)*	**80.2**	**67.2**	**67.3**	0.1	Negligible
Blackfriars Station (BBFR18)	**109.0**	**90.3**	**90.5**	0.2	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		
The Mermaid Conference Centre (BBFR9)	**86.1**	**71.7**	**71.7**	0.0	Negligible

*Notes: Emboldened figures indicate an exceedance of the objective/limit value which is 40µg/m³ 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 Blackfriars Bridge Foreshore site is 1.0µg/m³ which is predicted at the Thames Path (BBFR16). However, the annual mean objective / limit value (40µg/m³) does not apply here. The largest increase at a receptor of relevant exposure to the annual mean concentration is 0.2µg/m³ at residential properties at King's Bench Walk (BBFR1). This increase is described as negligible magnitude according to the criteria detailed in Volume 2. There is predicted to be a large decrease in concentrations at the President (BBFR15/19) due to the ship relocating temporarily during the construction works.

4.5.9 The significance of the effect at residential properties at King's Bench Walk (BBFR1), Globe View (BBFR12), 1-16 Blackfriars Road (BBFR13), River Court (BBFR14) and the schools, City of London School (BBFR10) and St Paul's Choir School (BBFR11), which have a high sensitivity to local air quality, is **negligible** (according to the criteria detailed in Volume 2). At Thames Path (BBFR16), River Thames (BBFR17) and Inner Temple Gardens (BBFR2),the significance is **minor adverse** as while the annual mean objective/limit value would not apply at these receptors, the hourly objective / limit value would. At the President (BBFR15/19) which would be relocated during construction and where the hourly objective / limit value applies, the significance is **major beneficial**. The other sensitive receptors are predicted to have **negligible** effects from NO_2.

PM_{10} concentrations

4.5.10 Predicted annual mean PM_{10} concentrations for the modelled scenarios, taking account of emissions from construction road traffic, tugs for river barges and construction plant, are shown in Vol 18 Table 4.5.2. This table details the forecast PM_{10} concentrations at specific sensitive receptors. Additionally, contour plots are provided (Vol 18 Figures 4.5.5 to Vol 18 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 18 Figure 4.5.8 (see separate volume of figures).

4.5.11 The modelled concentrations in Vol 18 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) at all but two receptors in the baseline case and one receptor in the base and development cases, decreasing 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 no or a very small increase over the base case due to construction activities at the Blackfriars Bridge Foreshore site except at the President (BBFR15/19) where there is a small improvement due to relocation of the ship. With no exceedances of the annual mean PM_{10} objective / limit value at any relevant receptors in the development case, the significance of the effects would be **negligible**.

Vol 18 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					
King's Bench Walk residential (BBFR1)	29.0	26.1	26.1	0.0	Negligible
River Court residential (BBFR14)	29.7	26.3	26.3	0.0	Negligible
1-16 Blackfriars Road residential (BBFR13)*	30.6	26.9	26.9	0.0	Negligible
Globe View, High Timber Street residential (BBFR12)	30.2	27.2	27.2	0.0	Negligible
City of London School building (BBFR10)	35.7	31.9	31.9	0.0	Negligible
St Paul's Choir School building (BBFR11)	25.1	22.8	22.8	0.0	Negligible
Receptors where the annual mean objective / limit value does not apply					

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		
Crown Plaza Hotel (BBFR6)	38.3	32.6	32.6	0.0	Negligible
Blackfriars PH (BBFR7)	39.4	33.4	33.4	0.0	Negligible
1 Temple Avenue (BBFR20)	33.6	29.9	29.9	0.1	Negligible
Sion Hall (BBFR3)	32.7	29.2	29.3	0.1	Negligible
60 Victoria Embankment (BBFR4)	34.2	30.4	30.5	0.0	Negligible
100 Victoria Embankment (BBFR5)	31.8	28.0	28.0	0.0	Negligible
President (BBFR15/19)*	37.6	33.1	32.6*	-0.6	Small
Thames Path (BBFR16)	**49.5**	**43.1**	**43.4**	0.2	Negligible
River Thames (BBFR17)	28.3	25.5	25.6	0.1	Negligible
Inner Temple Gardens (BBFR2)	34.9	30.9	31.0	0.1	Negligible
Puddle Dock Mermaid Theatre (BBFR8)*	31.2	27.6	27.6	0.0	Negligible
Blackfriars Station (BBFR18)	**40.7**	35.9	35.9	0.1	Negligible
The Mermaid Conference Centre (BBFR9)	33.0	29.3	29.3	0.0	Negligible

*Notes: * 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 With regard to the daily mean PM_{10} concentrations, Vol 18 Table 4.5.3 shows the predicted number exceedances of the daily PM_{10} standard (50µg/m^3) for each modelled scenario. The standard allows no more than 35 exceedances in a year.

4.5.13 The results in Vol 18 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. Again, this decrease is due to predicted reductions in background concentrations and improved vehicle engine technology. The results for the development case show a maximum increase of two days per year with concentrations above 50µg/m^3 compared with the base case at the modelled receptors due to construction works at the Blackfriars Bridge Foreshore site, except at the President (BBFR15/19) where there is medium improvement due to relocation of the ship during construction works.

4.5.14 An exceedence of the daily objective / limit value is predicted at the Crown Plaza Hotel (BBFR6) in 2010. Exceedences of the daily objective / limit value are also predicted at the Thames Path (BBFR16) receptor Blackfriars PH (BBFR7), the Mermaid Conference Centre (BBFR9) and the President (BBFR15/19*) in all scenarios and the Blackfriars Station (BBFR17), 1 Temple Avenue (BBFR20), Sion Hall (BBFR3), 60 Victoria Embankment (BBFR4) and Inner Temple Gardens (BBFR2)receptors in the baseline case, although it is noted that the criteria do not apply at these locations. All receptors are predicted to experience **negligible** effects.

Vol 18 Table 4.5.3 Air quality – predicted exceedances of the daily PM_{10} standard

Receptor	Predicted number of days > 50 µg/m^3			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 daily objective / limit value applies					
King's Bench Walk residential (BBFR1)	24	15	15	0	Negligible
River Court residential (BBFR14)	26	16	16	0	Negligible
1-16 Blackfriars Road residential (BBFR13)*	30	17	17	0	Negligible
Globe View, High Timber	28	18	18	0	Negligible

Receptor	Predicted number of days > 50 µg/m^3			Change between base and dev cases (days)	Magnitude of impact
	2010 baseline	Peak construction year base case	Peak construction year dev case		
Street residential (BBFR12)					
City of London School building (BBFR10)	**53**	35	35	0	Negligible
St Paul's Choir School building (BBFR11)	13	8	8	0	Negligible
Crown Plaza Hotel (BBFR6)	**68**	**38**	**38**	0	Negligible
Puddle Dock Mermaid Theatre (BBFR8)*	32	19	19	0	Negligible
Receptors where the daily mean objective / limit value does not apply					
Blackfriars PH, Queen Victoria Street (BBFR7)	**75**	**41**	**42**	0	Negligible
1 Temple Avenue (BBFR20)	**43**	27	27	0	Negligible
Sion Hall (BBFR3)	**38**	25	25	0	Negligible
60 Victoria Embankment (BBFR4)	**45**	29	29	0	Negligible
100 Victoria Embankment (BBFR5)	35	21	21	0	Negligible
President (BBFR15/19)*	**64**	**41**	**38***	-3	Small
Thames Path (BBFR16)	**162**	**103**	**104**	2	Medium
River Thames (BBFR17)	22	14	14	0	Small
Inner Temple	**49**	31	31	0	Negligible

Receptor	Predicted number of days > 50 µg/m^3			Change between base and dev cases (days)	Magnitude of impact
	2010 baseline	Peak construction year base case	Peak construction year dev case		
Gardens (BBFR2)					
Blackfriars Station (BBFR18)	32	19	19	0	Negligible
The Mermaid Conference Centre (BBFR9)	**84**	**54**	**55**	0	Negligible

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

Sensitivity test for programme delay

4.5.15 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 18 Appendix N), there would be no new receptors requiring assessment as a result of a one year delay.

Construction dust

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

4.5.17 Dust sensitive receptors have been identified in the vicinity of the Blackfriars Bridge Foreshore site in accordance with the criteria in Volume 2, as described in Vol 18 Table 4.4.6. A summary of the approximate numbers of receptors in distance bands from the Blackfriars Bridge Foreshore site is detailed in Vol 18 Table 4.5.4.

Vol 18 Table 4.5.4 Air quality – numbers of dust sensitive receptors

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

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

4.5.18 In line with the Institute of Air Quality Management (IAQM) guidance (2012)[11], the site has been categorised using the criteria given in Volume

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.

4.5.19 The demolition for the Blackfriars Bridge Foreshore site is classified as a 'small' dust emission class. This classification is based on the small size of the demolition volumes, which would be 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.

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

4.5.21 The construction proposed for the Blackfriars Bridge Foreshore site has a 'high' dust emission class. This classification is based on the quantity of concrete to be used which may be batched on-site and receptors being within 20m of the site. This makes the site high risk for construction works.

4.5.22 There would be 50-100m of unpaved haul roads on site and the number of daily HGV movements would be 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.

4.5.23 The risk categories for the four activities are summarised in Vol 18 Table 4.5.5. This summary of these risks does not take into account the measures outlined in the *CoCP (Part A*).

Vol 18 Table 4.5.5 Air quality – summary of construction dust risks

Source	Dust soiling / PM10 effects
Demolition	Medium risk site
Earthworks	High risk site
Construction	High risk site
Trackout	Medium risk site

Note: without CoCP measures

4.5.24 On this basis, the development at the Blackfriars Bridge Foreshore site is classified as a high risk site overall.

4.5.25 Although the receptor sensitivity (with respect to construction dust nuisance) is identified as medium for all receptors apart from the River Thames and the President (as identified in Vol 18 Table 4.4.6), due to the duration of the works with receptors within 20m, the sensitivity of the area has been defined as 'high'.

4.5.26 With regard to the significance of effects, a high risk site with a high sensitivity of the area would result in a moderate adverse effect without control measures during earthworks and construction. 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) for dust sensitive receptors within 20m of the site. At dust sensitive receptors beyond 20m the effect would be **negligible** with control measures in place. The significance of the effect for each receptor is summarised in Vol 18 Table 4.5.6.

Vol 18 Table 4.5.6 Air quality – significance of construction dust effects

Receptor	Significance of effect
Kings Bench Walk residential (BBFR1)	Negligible
River Court residential (BBFR14)	Negligible
1-16 Blackfriars Road residential (BBFR13)*	Negligible
Globe View, High Timber Street residential (BBFR12)	Negligible
City of London School building (BBFR10)	Negligible
St Paul's Choir School building (BBFR11)	Negligible
Crown Plaza Hotel (BBFR6)	Negligible
Blackfriars PH, Queen Victoria Street (BBFR7)	Negligible
1 Temple Avenue (BBFR20)	Negligible
Sion Hall (BBFR3)	Negligible
60 Victoria Embankment (BBFR4)	Negligible
100 Victoria Embankment (BBFR5)	Negligible
The President (BBFR15/19)*	Minor adverse
Thames Path (BBFR16)	Minor adverse
River Thames (BBFR17)	Minor adverse
Inner Temple Gardens (BBFR2)	Negligible
Puddle Dock Mermaid Theatre (BBFR8)*	Negligible
Blackfriars Station (BBFR18)	Minor adverse
Mermaid Conference Centre (BBFR9)	Negligible

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 18 Table 4.6.1 shows the predicted maximum ground level odour concentrations at the Blackfriars Bridge 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, 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 Volume 2.

Vol 18 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	7	

4.6.2 In Vol 18 Table 4.6.1 above, the 98th percentile is shown as zero as air would be released from the ventilation columns 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 columns during a typical year with concentrations reducing rapidly away from this area. There would be a maximum of seven 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 30m of the ventilation columns which could include the closest part of Paul's Walk to the ventilation columns. Odour would not be detectable at any building facades or on the President vessel 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 As described in Section 4.3, there would not be any cumulative construction effects. Therefore the effects on local air quality and dust would remain as described in Section 4.5 above. This would also be the case if the programme for the Thames Tideway Tunnel project was delayed by approximately one year.

Operational effects

4.7.2 As described in Section 4.3, there would not be any cumulative construction effects. Therefore the effects on odour 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. 4.2.18), 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 City of London Corporation prior to commencement of construction at the Blackfriars Bridge 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 18 Table 4.10.1 Air quality – summary of construction assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Residential - Upper floors of Kings Bench Walk (BBFR1)	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 - River Court, south bank of the river (BBFR14)	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 - 1-16 Blackfriars Road (BBFR13)*	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 - Globe View, High Timber Street (BBFR12)	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 - City of London School building (BBFR10)	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 - St Paul's	Local air quality – effects from construction	Negligible	None	Negligible

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Choir School building (BBFR11)	road traffic, tugs for river barges and plant emissions			
	Effects from construction dust	Negligible	None	Negligible
Hotel - Crown Plaza Hotel (BBFR6)	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
Public House - Blackfriars PH, Queen Victoria Street (BBFR7)	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 – 1 Temple Avenue (BBFR20)	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 - Sion Hall (BBFR3)	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 / retail - 60 Victoria Embankment (BBFR4)	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 / retail - 100	Local air quality – effects from construction	Negligible	None	Negligible

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Victoria Embankment (BBFR5)	road traffic, tugs for river barges and plant emissions			
	Effects from construction dust	Negligible	None	Negligible
Restaurant - President (BBFR15/19)*	Local air quality – effects from construction road traffic, tugs for river barges and plant emissions	Major beneficial	None	Major beneficial
	Effects from construction dust	Minor adverse	None	Minor adverse
Recreational - Thames Path (BBFR16)	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 - River Thames (BBFR17)	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 - Inner Temple Gardens (BBFR2)	Local air quality – effects from construction road traffic, tugs for river barges and plant emissions	Minor adverse	None	Minor adverse
	Effects from construction dust	Negligible	None	Negligible
Recreational - Puddle Dock Mermaid Theatre (BBFR8)*	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
Other - Blackfriars	Local air quality – effects from construction	Negligible	None	Negligible

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Station (BBFR18)	road traffic, tugs for river barges and plant emissions			
	Effects from construction dust	Minor adverse	None	Minor adverse
Other - Mermaid Conference Centre (BBFR9)	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 18 Table 4.10.2 Odour – summary of operational assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Residential - Upper floors of Kings Bench Walk (BBFR1)	Odour	Negligible	None	Negligible
Residential - River Court, south bank of the river (BBFR14)		Negligible	None	Negligible
Residential - 1-16 Blackfriars Road (BBFR13)*		Negligible	None	Negligible
Residential - Globe View, High Timber Street (BBFR12)		Negligible	None	Negligible
Educational - City of London School building (BBFR10)		Negligible	None	Negligible
Educational - St Paul's Choir School building (BBFR11)		Negligible	None	Negligible

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Hotel - Crown Plaza Hotel (BBFR6)		Negligible	None	Negligible
Public House- Blackfriars PH, Queen Victoria Street (BBFR7)		Negligible	None	Negligible
Commercial – 1 Temple Avenue (BBFR20)		Negligible	None	Negligible
Commercial - Sion Hall (BBFR3)		Negligible	None	Negligible
Commercial/retail - 60 Victoria Embankment (BBFR4)		Negligible	None	Negligible
Commercial/retail - 100 Victoria Embankment (BBFR5)		Negligible	None	Negligible
Restaurant – President (BBFR15/19)*		Negligible	None	Negligible
Recreational - Thames Path (BBFR16)		Negligible	None	Negligible
Recreational - River Thames (BBFR17)		Negligible	None	Negligible
Recreational - Inner Temple Gardens (BBFR2)		Negligible	None	Negligible
Recreational - Puddle Dock Mermaid Theatre (BBFR8)		Negligible	None	Negligible
Other - Blackfriars Station (BBFR18)		Negligible	None	Negligible
Other - Mermaid Conference Centre (BBFR9)		Negligible	None	Negligible

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

References

[1] Greater London Authority and London Councils, *Best Practice Guidance: The Control of Dust and Emissions from Construction and Demolition* (November 2006).

[2] Defra, *Local Air Quality Management- Technical Guidance, LAQM.TG(09)* (2009).

[3] Highways Agency. *Design Manual for Roads and Bridges,* Volume 11 Environmental Assessment, Section 3 Environmental Assessment Techniques, Part 1 pg D-1 HA207/07 Air Quality, May 2007.

[4] Michigan Environmental Science Board, *Health Effects of Low-Level Hydrogen Sulfide in Ambient Air* (2000).

[5] UK Government. *Environment Act 1995*, http://www.legislation.gov.uk/ukpga/1995/25/contents. Accessed June 2012.

[6] Defra. *Local air quality management background maps*. Available at: http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html. Accessed June 2012.

[7] City of London Corporation, Personal Communication with EHO, July 2012.

[8] World Health Organization, *Air Quality Guidelines for Europe* Second Edition (2000), Chapter 6.6.

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[11] Institute of Air Quality Management. *Guidance on the Assessment of the Impacts of Construction on Air Quality and the Determination of their Significance* (January 2012).

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.18**

Volume 18 Blackfriars Bridge 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 18: Blackfriars Bridge 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 Blackfriars Bridge 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 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 Fleet Main CSO.

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 Blackfriars Bridge 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 construction and operation of 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 18 Blackfriars Bridge 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 Blackfriars Bridge Foreshore would be located predominantly on the foreshore. Construction activities would occur over five years, with structures in place for approximately four and a half years. The elements of the construction of the proposed development of relevance to aquatic ecology would be as follows:

a. The installation of sheet piling to create a temporary cofferdam on the foreshore using a temporary jack-up barge, or similar equipment as shown in the Construction Phases: Phase 1 Site Setup drawing.

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. Regular barge movements with a peak monthly average of six barge movements per day. Grounding out (resting of barges on the river bed) should not occur except occasionally on the lowest tides.

e. The creation of a temporary piled steel deck adjacent to the cofferdam on the upstream side.

f. The relocation of the Blackfriars Millennium Pier and the creation of a new permanent piled landing stage, pier/pedestrian ramp and pontoon downstream of Blackfriars Bridge to replace the existing structure. There would be dredging of an area of subtidal sediment in the immediate vicinity to facilitate this.

5.2.3 The construction of in-river structures, and in particular the temporary works cofferdam, 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 (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 will consider the need to minimise environmental impacts and should consider the use of lattice structure barge grids where appropriate. In-river structures, including campsheds, will 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 will be subject to a method statement that will 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).

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

d. Limiting allowable noise and vibration levels such that part of the river cross-section is 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. When vibro-piling is undertaken, slowly increasing the power of the driving to enable fish to swim away 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 will 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

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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).

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 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. Dredging will be undertaken in accordance with any dredging licenses and required permissions from the MMO and EA to ensure stability of defence walls is not affected, and for ecological requirements and compliance with the Water Framework Directive. Where sites that may require dredging lie within the stretch of the river known to support spawning habitat for smelt and dace, due regard should be given so as to minimise any impact on biodiversity within the river and the Salmon and Freshwater Fisheries Act 1975 (CoCP *Part A* Section 8).

j. 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).

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 8).

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

m. Appropriate measures will 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).

n. 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 Blackfriars Bridge Foreshore.)

5.2.6 The *CoCP Part B* at Blackfriars Bridge Foreshore commits to the following measures that are of relevance to aquatic ecology:

a. A site-specific lighting plan is required. The lighting will address the impact on 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 site will adhere to standard and extended standard working hours (*CoCP Part B* Section 4).

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

Operation

5.2.7 The 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 Fleet Main CSO would be intercepted at the Blackfriars Bridge Foreshore site. Based on the base case (which includes permitted Thames Tideway 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 Fleet Main CSO are anticipated be 571,000m^3 per annum over a total of 23 discharge events (or spills) by 2021. The discharge is predicted to reduce to 37,000m^3 per annum over four discharge events once the Thames Tideway Tunnel project is operational. This represents an approximately 94% 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 from 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 structure and discharge apron would consist of buried rip-rap which would be overlaid with an appropriate substrate material.

5.2.11 The Blackfriars Millennium Pier would be relocated and used for the movement of vessels. Grounding out should not occur except

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

occasionally on the lowest tides, since mooring of vessels would be within the subtidal area.

Environmental design measures

5.2.12 Generic design principles of relevance to aquatic ecology at Blackfriars Bridge Foreshore are as follows:

a. Structures in or over the river would be reduced in scale as far as possible and would be designed to take account of effects on river flow, the needs of river users, aquatic ecology and visual effects

b. Horizontal or vertical timber fenders would be included in the design of river walls in order to promote aquatic ecology.

c. Scour protection would 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.

d. Where practicable, at the base of the foreshore structure, measures such as low level entrapment features would be provided to encourage retention of sediment to promote aquatic ecology.

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

f. Lighting would 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).

g. No lighting would be proposed in the tidal Thames or directed towards it unless required for navigational purposes.

5.2.13 In addition the footprint of the permanent works has been reduced in size compared to earlier iterations of the proposed development.

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*. Specific comments relevant to this site for the assessment of aquatic ecology are presented in Vol 18 Table 5.3.1.

Vol 18 Table 5.3.1 Aquatic ecology - stakeholder engagement for Blackfriars Bridge Foreshore

Organisation	Comment	Response
City of London Corporation (phase two consultation - January 2012)	Preliminary environmental information concluded that “the permanent loss of intertidal foreshore is considered to be a moderate adverse effect”. Details of suitable local mitigation measures and a comprehensive	Mitigation measures are incorporated into the *Environmental Statement*, and in particular with respect to landtake are considered at a project-wide level within Vol 3 Section 5.

Organisation	Comment	Response
	monitoring programme are required.	
City of London Corporation (phase two consultation - January 2012)	Every effort should be made to ensure that the encroachment of the new structures into the River and the relocated Blackfriars Millennium Pier create minimal impacts on the environmental functions of the River.	The design of the Blackfriars Bridge Foreshore site has minimised working areas as much as possible.
City of London Corporation (scoping opinion – April 2011)	The environmental impact assessment (EIA) should consider the impact of new structures in the river on foreshore erosion and potential erosion damage to existing flood defences, which in some cases provide ecological habitat.	The effect of any new structures on the hydraulic regime of the river has been modelled. Impacts pertinent to aquatic ecology are assessed.
Environment Agency (Section 28 consultation response – October 2012)	Permanent encroachment into the river should be minimised further if possible.	The footprint of the permanent structure has been minimised as far as possible to accommodate the necessary works therefore further mitigation on-site is not possible.
	Habitat loss of foreshore is significant.	The assessment identifies that during operation the permanent loss of intertidal foreshore is considered to be a moderate adverse effect. The permanent loss of habitat at the Blackfriars Bridge site contributes to an overall loss arising from all of the foreshore sites. Compensation for this project-wide permanent loss of foreshore habitat is considered described in Vol 3 Section 5 (see para. 5.9.2).
	River Bus pier relocation has effects on foreshore downstream and should be assessed.	The effects of the relocation of the Blackfriars Millennium Pier have been included as part of this assessment.

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 desk study and survey 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 Tideway. Locations as close to Blackfriars Bridge Foreshore as possible have been selected. Details of the background and desk study data sets are provided in Vol 2 Section 5.

5.3.4 Surveys for fish and invertebrates were undertaken during October 2010, within the proposed development site and within 100m radius of the site boundary. 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 the nearest sampling location to the site was on the opposite bank to Blackfriars Bridge Foreshore. Surveys for algae were undertaken at eight sampling locations in May 2012, comprising each of the foreshore sites, including Blackfriars Bridge 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, i.e. 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 on aquatic ecology arising from the construction of the proposed development at the Blackfriars Bridge Foreshore site. There are no other Thames Tideway Tunnel project sites which could give rise to additional effects on aquatic ecology receptors within the construction assessment area for this site, therefore no other Thames Tideway Tunnel project sites are considered in this assessment.

5.3.7 London Eye Pier Extension is considered part of the construction base case for aquatic ecology. 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.

5.3.8 In terms of cumulative effects, the schemes listed in the site development schedule (Vol 18 Appendix N) that would be under construction during construction at the Blackfriars Bridge Foreshore site are in-land and would not have impacts on aquatic ecology thus there are no schemes that could lead to a cumulative impact at Blackfriars Bridge Foreshore. Therefore no cumulative impact assessment has been undertaken.

5.3.9 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

5.3.10 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. Although permanent structures such as the relocated Blackfriars Millennium Pier, and permanent cofferdam would be in place prior operation, effects on receptors would occur for the lifetime of such structures and they are therefore considered to be operational effects. There are no site-specific variations for undertaking the operational assessment of this site.

5.3.11 Section 5.6 details the likely significant effects arising from the operation of the proposed development at the Blackfriars Bridge 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.

5.3.12 Only the scheme identified in para. 5.3.7, the London Eye Pier Extension, is considered relevant to the aquatic ecology base case. Similarly, there are no other schemes listed in the site development schedule (Vol 18 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 Blackfriars Bridge Foreshore. Therefore no cumulative impact assessment has been undertaken.

5.3.13 As with construction (see para. 5.3.9), 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

5.3.14 The assumptions and limitations associated with this assessment are presented in Vol 2 Section 5. Assumptions and limitations specific to this site are outlined below.

Assumptions

5.3.15 It has been assumed that:

a. Vibro-piling would be utilised.

b. It would be necessary to remove all alluvial and other deposits above the natural gravel within the temporary cofferdam in order to establish a stable construction platform, as detailed in Section 5.2.

c. The relocation of the President would be to the Chrysanthemum Pier, which is currently under construction, and would not involve any new infrastructure, dredging to create a new berth, or increase in the maintenance dredging regime.

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

e. The creation of a new permanent piled landing stage, pier/pedestrian ramp and pontoon downstream of Blackfriars Bridge to replace the existing structure (Blackfriars Millennium Pier) would require dredging on an ongoing (i.e., permanent) basis in order to maintain access (known as ‘maintenance dredging’.). Since the existing pier requires maintenance dredging there would be no net increase in the dredged area, simply a re-location of it to the new pier position.

f. 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

5.3.16 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 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 Blackfriars Bridge Foreshore falls within the non-statutory River Thames and Tidal Tributaries Site of Importance for Nature Conservation (Grade III of Metropolitan importance)[iii]. The SINC is designated by the Greater London Authority (GLA) and adopted by all boroughs which border the Thames. It 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 Tideway, 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*), 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], and the targets prescribed for this *HAP* are reflected in the City of London *BAP* (City of London Corporation, 2012)[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 Blackfriars Bridge Foreshore lies within the brackish zone of the river, which means that the fish and invertebrate communities which occur within the river at this location consist of freshwater tolerant marine species and salt-water tolerant freshwater species. Invertebrate diversity is generally lower than in the freshwater zone as species must be able to withstand some variations in salinity and a stressful environment. Stress is caused by the fluctuating tidal 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 is narrowest in the central London section of the tidal Thames, and is absent for much of the length of this site. There is intertidal habitat for a length of approximately 50m, including an area under Blackfriars Bridge within the site (Vol 18 Figure 5.4.1, see separate volume of figures). There is a narrow stretch of intertidal habitat in the

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

area in which the Blackfriars Millennium Pier would be relocated. The intertidal area consists of gravel foreshore dominated by pebbles and cobbles, indicating an environment that is heavily scoured. Smaller areas of sand, shingle and silt are also present. However, it is classified as the *BAP* priority habitat mudflats (Natural England, 2012)[7] and the priority habitat 'Thames Foreshore' of the City of London *BAP*.

5.4.11 The river in this location is confined by a constructed vertical river wall, and bridge abutments. There is no marginal vegetation and relatively little intertidal habitat. Vertical walls, sometimes clad with timber are identified as a priority habitat in the City of London *BAP* due to the communities of plants and invertebrates that they can support.

5.4.12 A summary of habitat types present, and other features of interest recorded during October 2010 surveys are presented in Vol 18 Table 5.4.1 The survey area is presented in Vol 18 Figure 5.4.1 (see separate volume of figures).

Vol 18 Table 5.4.1 Aquatic ecology - principal habitat, substrate and other features of interest at Blackfriars Bridge Foreshore

UK *BAP* target habitats present and features of interest	Substrate present in intertidal zone (approximate % cover)	Substrate present in subtidal zone
Gravel foreshore Sublittoral sand and gravels River wall Mudflats	Pebbles (50%) Cobbles (30%) Sand, shingle, silt (20%)	Pebbles Gravel Sand

Evaluation of habitats for Blackfriars Bridge Foreshore

5.4.13 The value of the habitats for individual aquatic ecology receptors is described in the relevant baseline sections. While the survey data indicates that the intrinsic value of the habitats at this site are low, for the purpose of this assessment the habitats are considered to be of medium-high (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 (ZSL) for 2003-2011 indicate common seal (*Phoca vitulina*) and harbour porpoise (*Phocoena phocoena*) have been observed in this area of the Thames.

Evaluation of marine mammals for Blackfriars Bridge 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 intertidal habitat for species of seal to use as a haul out site.

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 Blackfriars Bridge Foreshore during October 2010. Full details of the methodology and rationale for timing of surveys are presented in Vol 2 Section 5.

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 low fish abundance in the area of Blackfriars Bridge Foreshore site, with only 41 individuals captured in total. The range of species recorded and the number of individuals is presented in Vol 18 Table 5.4.2. The low abundance of freshwater species relative to estuarine resident and diadromous species at Blackfriars Bridge Foreshore such as roach, bream and dace is explained by the site location, which is towards the upstream end of the brackish zone (Vol 3 Figure 5.4.1, see separate volume of figures), where salinity is relatively close to the tolerance threshold of freshwater species.

Vol 18 Table 5.4.2 Aquatic ecology - results of fish surveys at Blackfriars Bridge

Common name	Scientific name	Number of individuals Oct 2010	Guild
Flounder	*Platichthys flesus*	13	Estuarine resident
Common goby	*Pomatoschistus microps*	10	Estuarine resident
Sand goby	*Pomatoschistus minutus*	1	Estuarine resident
Smelt	*Osmerus eperlanus*	9	Diadromous
Eel	*Anguilla anguilla*	3	Diadromous

Common name	Scientific name	Number of individuals Oct 2010	Guild
Common bream	*Abramis brama*	2	Freshwater
Dace	*Leuciscus leuciscus*	2	Freshwater
Roach	*Rutilus rutilus*	1	Freshwater

Juvenile fish surveys

5.4.20 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.

5.4.21 Surveys for juvenile fish were undertaken five sites sampled six times between May and September 2011 as part of the project wide assessment. The site locations are presented in Vol 2 Figure 5.4.4 (see separate volume of figures). The aim of the surveys was to record juvenile fish migrations through the Tideway to 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 data from the juvenile fish surveys on the opposite bank to Blackfriars Bridge Foreshore site are shown in Vol 18 Table 5.4.3. The findings are relevant to this site because it gives context to the assemblage of fish that may be expected to be found in this reach of the river. However, it should be noted that the survey area at the opposite bank has a greater extent of intertidal foreshore habitat than the Blackfriars Bridge Foreshore site (see para. 5.4.10)

Vol 18 Table 5.4.3 Aquatic ecology - results of 2011 juvenile fish surveys on the opposite bank to Blackfriars Bridge Foreshore

Common name	Scientific name	Number of individuals					
		Survey					
		1 May	2 late May	3 June	4 July	5 Aug	6 Sept
Flounder	*Platichthys flesus*	37	325	86	13	1	9
Smelt	*Osmerus eperlanus*	0	1	0	0	1	0
Eel	*Anguilla anguilla*	2	0	1	8	3	0
Common bream	*Abramis brama*	0	0	0	3	0	2

Common name	Scientific name	Number of individuals					
		Survey					
		1 May	2 late May	3 June	4 July	5 Aug	6 Sept
Dace	*Leuciscus leuciscus*	4	0	0	0	0	0
Roach	*Rutilus rutilus*	0	2	10	0	0	0
Perch	*Perca fluviatilis*	3	4	0	0	0	0
Goby	*Pomatoschistus* spp.	0	0	0	168	382	25
Sea bass	*Dicentrarchus labrax*	0	0	5	126	57	4
Bullhead	*Cottus gobio*	0	0	0	0	1	0

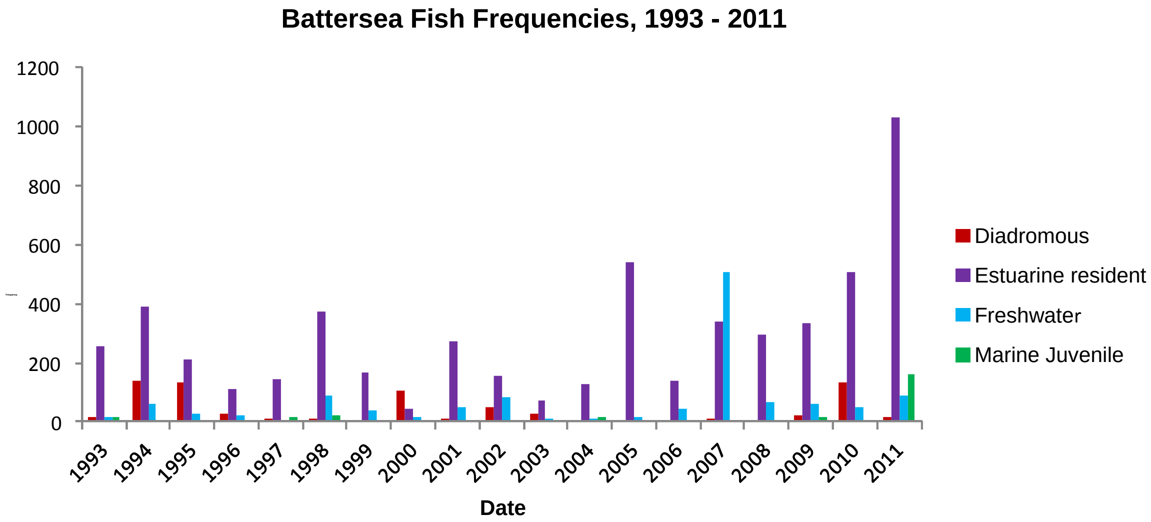
5.4.22 Post-larval flounders dominated the catch from surveys one, two, and three. Flounder were caught in the shallow littoral zone, indicating early springtime colonisation from marine spawning sites. From surveys three to six, sea bass (*Dicentrarchus labrax*) and gobies (*Pomatoschistus* sp.) were numerous. Returns from the sixth survey were low. The survey area results indicate that the area on the opposite bank to Blackfriars Bridge Foreshore site 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 survey area does not however offer spawning habitat.

Environment Agency background data

5.4.23 The surveys described in paras. 5.4.17 to 5.4.22 provide up-to-date baseline information directly relevant to fish community composition at Blackfriars Bridge Foreshore site. 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 surveys are provided in Vol 2 Section 5. There is an EA sampling site at Vauxhall, 3.5km upstream. The EA data at this location indicates that the most well represented species are dace, flounder, roach, sand-smelt and eels, which are a similar assemblage to the findings of the October 2010 survey shown in Vol 18 Table 5.4.2 and reflect the mid tidal Thames position of the site. EA data for the Vauxhall site are, however, limited to spring and autumn surveys in 1992 and 1993.

5.4.24 A more comprehensive survey dataset exists for Battersea, located 6km upstream, where EA surveys have been carried out every year from 1993 to 2011. Fifteen fish species are recorded for Battersea. These show fairly consistent catches in trawls but some indication of increasing seine-net catches in recent years. Catches are dominated by estuarine resident fish (Vol 18 Plate 5.4.1) 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, a range that includes species found in October 2010 survey shown in Vol 18 Table 5.4.2. Other migratory species such as salmon and sea trout must pass through the area but are too infrequently present to be detected by only one or two surveys per year. 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 18 Plate 5.4.1 Aquatic ecology - long-term EA total fish catches from Battersea site



Water quality and current fish baseline

5.4.25 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] the progressive improvement of fish populations from the 1960s onwards has been recorded. The ecology of the tidal Thames has undergone further improvement in recent decades, with some 125 fish species now recorded by the EA.

5.4.26 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 event 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).

5.4.27 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.

5.4.28 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.

5.4.29 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 Blackfriars Bridge Foreshore

5.4.30 The Blackfriars Bridge Foreshore site is considered to be of medium (borough) value for fish due to the limited intertidal habitat. This valuation is supported by the limited assemblage of species recorded at the site. Although the juvenile fish survey recorded a broad assemblage of species, it is considered that this is likely to be a result of the greater extent of intertidal foreshore on the opposite bank than at the Blackfriars Bridge Foreshore site (see para. 5.4.10).

Invertebrates

5.4.31 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.

5.4.32 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

5.4.33 A single day survey was undertaken at Blackfriars Bridge Foreshore site during October 2010. The area covered by the survey is the same as that described for the fish survey above (paras. 5.4.17 to 5.4.19) and illustrated in Vol 18 Figure 5.4.1 (see separate volume of figures). Details of the sampling methods used can be found in Vol 2 Section 5. Two intertidal and two subtidal samples were taken.

5.4.34 The invertebrates collected during the October 2010 field surveys are presented in Vol 18 Table 5.4.4 below. 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 18 Table 5.4.4 Aquatic ecology – invertebrate fauna sampled at Blackfriars Bridge in October 2010

Taxa	CCI Score	No. of individuals - subtidal samples		No. of individuals - intertidal samples		
Sample numbers		**Air lift 1**	**Air lift 2**	**Kick sample**	**Sweep net 1**	**Sweep net 2**
Potamopyrgus antipodarum	1	0	6	0	0	0
Radix balthica	1	0	1	0	0	0
Palaemon longirostris	5	3	0	0	0	0
Lekanesphaera hookeri	2	1	0	0	0	0
Oligochaeta	-	20	5	0	6	2
Erpobdella sp.	-	1	9	0	0	0
Crangon crangon	-	1	1	0	0	0
Eriocheir sinensis	-	0	1	0	0	0
Apocorophium lacustre	8	200	700	3	0	0

Taxa	CCI Score	No. of individuals - subtidal samples		No. of individuals - intertidal samples		
Sample numbers		Air lift 1	Air lift 2	Kick sample	Sweep net 1	Sweep net 2
Gammarus sp	-	20	0	0	0	0
Gammarus zaddachi	1	135	120	0	0	0
Number of taxa	**-**	**8**	**8**	**1**	**2**	**1**

5.4.35 Blackfriars Bridge Foreshore site was characterised by low diversity in the intertidal zone and higher diversity in subtidal zones relative to other sites surveyed within the same reach of the tidal Thames. Subtidal samples were relatively diverse (for this area of the tidal Thames), and moderately pollution sensitive groups, such as *Gammarus zaddachi* (a brackish species of shrimp) and *Apocorophium lacustre* were abundant.

5.4.36 The low invertebrate diversity and abundance in the intertidal area is likely to reflect the physical conditions at the site. There is a very limited intertidal zone. Wave washing from the tide and passing river craft is intense and affects the entire width of the intertidal habitat. The site lies within the brackish zone of the river which means that invertebrates are subject to considerable variations in salinity.

5.4.37 The majority of taxa present are brackish species, with varying tolerance of 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 saline influence compared to upstream sites is demonstrated by the presence of *Lekanesphaera hookeri* (a water louse), which are generally associated with estuarine or marine conditions.

5.4.38 The only species of high nature conservation importance was the mudshrimp *A. lacustre* (CCI 8), a RDB species which was present in subtidal samples at the site. EA data have however shown *A. lacustre* to be common in the tidal Thames (see para. 5.4.39 to 5.4.44), and therefore the relative value of the invertebrate community is not considered to be of higher value in this instance.

Environment Agency background data

5.4.39 Blackfriars Bridge is located approximately 0.9km downstream of the EA site at South Bank Centre, which is the nearest invertebrate sampling location with recent data (2005-2007). South Bank Centre was sampled ten times in 2005 using a 0.1m² core sampler, six times in 2006 using a 0.01m² grab sampler and 31 times in 2007 using a grab sampler.

5.4.40 The most abundant taxa that have been recorded at South Bank Centre between 2005 and 2007 included *Limnodrilus hoffmeisteri* and other Oligochaeta worms, which thrive in organically polluted conditions, together with other pollution tolerant species such as the snail

Potamopyrgus antipodarum. However, *G. zaddachi*, a moderately pollution-sensitive species was also highly abundant

5.4.41 In addition to the native *G. zaddachi*, the amphipod *Gammarus tigrinus*, of North American origin, was recorded at South Bank Centre in 2007. The species was not recorded in samples taken at Blackfriars Bridge Foreshore in 2010. It is believed that this species of amphipod arrived in English *w*aters 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.

5.4.42 Species diversity recorded at Blackfriars Bridge Foreshore in 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.

5.4.43 The differences between samples taken in 2010 at Blackfriars Bridge Foreshore and samples from South Bank Centre, including the absence of *Theodoxus fluviatilis* and lower relative abundance of Polychaeta worms (one of the most diverse groups at South Bank Centre) and *P. antipodarum* at Blackfriars Bridge are likely to reflect subtle differences in habitat, seasonal and sampling variation and, potentially, water quality (there are a number of CSO outfalls in the area). Higher species richness recorded in some sample years at South Bank Centre may reflect greater sampling frequency.

5.4.44 Chinese mitten crab (*Eriocheir sinensis*), an invasive and non-indigenous species, was sampled in the subtidal zone of the site. Individual mitten crabs were captured at a number of sampling locations along the tidal Thames. 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

5.4.45 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.5. 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.

5.4.46 The analysis is described in further detail in Vol 3 Section 5.4. The following summary is relevant to the brackish zone of the tidal Thames in which the Blackfriars Bridge Foreshore site is located.

5.4.47 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.

5.4.48 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 Blackfriars Bridge Foreshore

5.4.49 The Blackfriars Bridge Foreshore site is considered to be of medium (borough) importance due to the dominance of the invertebrate community by a limited range of pollution tolerant species. Whilst of limited conservation value, the invertebrate community enriches the borough habitat resource. Only a single species of conservation importance (*A. lacustre*) was recorded, and it is ubiquitous within the tidal Thames.

Algae

5.4.50 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 both 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

5.4.51 The species found during the 2012 algal survey of Blackfriars Bridge Foreshore only recorded five species of algae of which *Blidingia minima* was dominant. These were all on the river wall and are shown in Vol 18 Table 5.4.5. All species are widespread and abundant in the tidal Thames.

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

Vol 18 Table 5.4.5 Aquatic ecology – marine algae sampled at Blackfriars Bridge Foreshore during 2012

Species	Survey observations	Species presence in the tidal Thames
Blidingia marginata	Common on the river wall, especially on the lower reaches.	Widespread and abundant.
Blidingia minima	Dominant on the upper reaches of the river wall.	Widespread and abundant.
Cladophora glomerata	Abundant on the lower reaches of the river wall.	Widespread and abundant.
Rhizoclonium riparium	Occasionally present on the river wall.	Common in the estuary.
Vaucheria sp.	Occasionally present on the 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.

Natural History Museum background data

5.4.52 Data was 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 Cleopatra's Needle, approximately 1km upstream, and all the records are shown in Vol 18 Table 5.4.6.

Vol 18 Table 5.4.6 Aquatic ecology – marine algae sampled at Cleopatra's Needle 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.
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

5.4.53 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.

5.4.54 Studies of the pelagic algae (para. 5.4.50) 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 Blackfriars Bridge Foreshore

5.4.55 None of the species recorded in Vol 18 Table 5.4.5 and Vol 18 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

5.4.56 Using the baseline set out in para. 5.4.1 to 5.4.55 the value accorded to each receptor considered in this assessment is set out in Vol 18 Table 5.4.7. The definitions of the receptor values and sensitivities used in this evaluation are set out in Vol 2 Section 5.

Vol 18 Table 5.4.7 Aquatic ecology – summary of receptors and their values/sensitivities at Blackfriars Bridge 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

5.4.57 The base case in Site Year 1 of construction would include the improvements at the five main sewage treatment works that discharge into the Thames Tideway (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 significant reduction in the occurrence of mass or population level fish mortalities with these schemes (i.e. hypoxia 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.

5.4.58 Given that CSOs within the tidal Thames would continue to spill, including the Fleet Main CSO, and no significant changes in habitat quality are anticipated the fish baseline for the Blackfriars Bridge 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.

5.4.59 The invertebrate analysis demonstrates that more pollution sensitive groups such as shrimps (*Gammaridae*) are subject to significant 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 brackish zone, including Blackfriars Bridge 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 significantly 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.

5.4.60 The scheme described in para. 5.3.7 would already be operational at the time construction of Thames Tideway Tunnel project commences and is therefore considered part of the construction base case. The London Eye Pier Extension would be delivered approximately 930m upstream and would consist of a floating pontoon held in position by two piles. However, the *Environmental Statement* for this scheme has concluded that no adverse ecological effects would arise (HR Wallingford, 2011)[18]. Therefore this would lead to no further change to the base case.

5.4.61 There is unlikely to be encroachment onto the tidal Thames foreshore for non-river dependent uses as this is restricted through *London Plan 2011* (GLA, 2012)[19] 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)[20] 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 other changes to current baseline from other developments are considered likely.

Operational base case

5.4.62 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 due to the reduced number of hypoxia events. However, as noted in para. 5.4.57 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 Fleet Main 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. 5.2.7: further details of projected spills are provided in Section 14 of this volume). Therefore recovery due to water quality improvements will be suppressed at Blackfriars Bridge Foreshore site. As a result there are unlikely to be significant 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 CSO may be less favourable for fish than the current baseline given the increase in frequency, volume and duration of CSO spills. At a river wide scale invertebrate communities will include more pollution sensitive components as noted in para. 5.4.59, 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 given the increase in frequency, volume and duration of CSO spills.

5.4.63 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 significantly 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.

5.4.64 The effects of the London Eye Extension would be as identified in para. 5.3.12.

5.4.65 As stated in para. 5.4.60 there is unlikely to be encroachment onto the tidal Thames foreshore for any other non-river dependent uses. Therefore no change to 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 2,380m^2 of temporary landtake (of which approximately 275m^2 would be from intertidal habitat close to Blackfriars Bridge, and the remainder from subtidal habitat) associated with the presence of the cofferdam. This represents 0.01% of the River

Thames and Tidal Tributaries SINC (Grade M). Soft material from within the cofferdam would be removed and a geotextile membrane used to separate the underlying substrate from the imported granular fill material. The temporary cofferdam would be in place for a total of five 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 negative, however due to the small area involved in the context of the wider SINC designation it is accorded low magnitude. The probability of the impact occurring is considered to be certain.

Sediment disturbance and consolidation

5.5.5 It has been assumed that the area between the outer edge of the cofferdam and the maximum extent of the working area would be subject to disturbance and consolidation due to the jack up barge operation. At Blackfriars Bridge Foreshore site this represents a total area of approximately 1795m^2 of intertidal habitat and 24415m^2 of subtidal habitat which would be affected by construction activities during the site establishment phase. Given the small area of intertidal habitat at this site, the habitat affected would be largely subtidal. There is also likely to be consolidation and disturbance due to barge movements. At Blackfriars Bridge there would be approximately a peak monthly average of approximately six barge movements per day.

5.5.6 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

5.5.7 The approach to addressing scour associated with the temporary structures is summarised in 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). No deposition currently occurs within the vicinity. With the temporary structure there would be sediment accumulation immediately upstream and downstream of the temporary works only.

5.5.8 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 will not be permitted to penetrate beyond the existing substrate layer (para. 5.3.15f) 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. Hydraulic modelling shows that there would be areas of low velocity water created in the lee of the structure and faster flowing water around the riverward faces. The impact on flow velocity is considered to be negligible.

Waterborne noise and vibration

5.5.10 There would be approximately 780m of sheet piling installed for the temporary and permanent cofferdams in addition to the piles for the temporary construction platform and relocated Blackfriars Millennium Pier which would also be piled. 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 of this volume.

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.

Increase in suspended sediment loads

5.5.12 Construction of the relocated Blackfriars Millennium Pier, piling operations, and barge movements are likely to lead to localised increases in suspended sediment with the possibility for effects on local and downstream habitats. It is predicted that the cofferdam would impact on scour patterns while in place, which could cause the mobilisation of increased levels of suspended solids, and potentially contaminants, into the river. Suspended sediment can have an effect on water quality and particularly DO. This is discussed at the project wide level in Vol 3 Section 5.

5.5.13 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.

5.5.14 The proposed dredge volume at this site is estimated at approximately 800m^3 for the Blackfriars Millennium Pier relocation. It has also been estimated that there would be a release of 5% of the dredged material to the water column and consequently sediment being released during the dredging operation. Results from the testing of sediment identified elevated arsenic concentrations slightly above the Threshold Effect Levels (TEL).

5.5.15 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)[21] 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)[22].

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 provided with these control measures and safeguards in place.

5.5.17 Impacts at the site resulting from releases of suspended sediment are considered to be low negative, probable and temporary.

Construction effects

5.5.18 The following section (paras. 5.5.19 to 5.5.46) describes the effects of the 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

5.5.19 There would be a temporary loss of approximately 275m^2 of intertidal habitat and 2105m^2 from subtidal habitat. The habitats affected by temporary landtake are presented in Vol 18 Table 5.4.1 and include gravel foreshore, sublittoral sand and gravels, river wall and mudflats. These habitats which are considered to be of medium-high (metropolitan) importance are represented elsewhere across the tidal Thames. The impact of temporary landtake is considered to be of low negative magnitude since the extent of the areas affected in the context of the overall size of the upper and middle tidal Thames is small.

5.5.20 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). The overall effect is considered to be **minor adverse**, given the medium-high (metropolitan) value of the receptor and low negative magnitude of impact.

Disturbance and consolidation of intertidal and subtidal habitat

5.5.21 There would be disturbance and consolidation of approximately 26210m^2 outside the temporary cofferdam during the site establishment phase due to the presence of a jack up barge to install the temporary cofferdam, and relocation of the Blackfriars Millennium Pier. 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-high (metropolitan) value of the habitats the effect is considered to be **minor adverse** due to the low negative magnitude of the impact.

Change in intertidal and subtidal habitat due to scour and accretion

5.5.22 The intertidal habitats at Blackfriars Bridge Foreshore are dominated by cobbles and pebbles with some sand, shingle and silt, with subtidal habitat comprising pebbles, gravel and sand (Vol 18 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 will 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.

5.5.23 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.

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

Marine mammals

Interference with the migrations of marine mammals within the tidal Thames

5.5.25 Noise, vibration and other construction activity has the potential to disturb mammals and deter them from passing the site. However, given the low-medium (local) value of the receptor at this site, the low negative magnitude of noise and vibration impacts, 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

5.5.26 The site is considered to offer little suitable habitat for fish due to the limited extent of the intertidal area. Loss of foreshore habitat is considered to be a medium negative impact, which on a medium (borough) receptor would result in a **minor adverse** effect.

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

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

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

5.5.28 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) value of the receptor and the low negative magnitude of the impact.

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 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 driving of sheet piles for the cofferdam 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 4 weeks for the deck and 8 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 a nursery area. 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 quality 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 levels of suspended sediment which may cause disorientation of fish.

5.5.36 Given the extent of the temporary cofferdam (approximately 780m of sheet piling), 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. It has been estimated that there would be a loss of 5% of the dredged material to the water column, and therefore an estimated 100m^3 of sediment being released during the dredging operation (including that associated with the re-located Blackfriars Millennium Pier). Adult fish are considered to be less likely to be affected as they are able to move away from the turbid water. Effects on juvenile fish are considered to be **negligible,** with natural recovery of sediments anticipated, given the medium (borough) value of the receptor and low negative magnitude of 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 cofferdam, and due to consolidation and disturbance of sediment due the site establishment phase. The effect is considered to be **negligible** due to the medium (borough) value of the receptor and the low negative magnitude of impact.

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

5.5.38 The area beneath the temporary cofferdam would also be lost as burrowing and feeding habitat for invertebrates during the entire construction period. 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 Given the medium (borough) value of the receptor and the low negative impact of habitat loss, the overall effect is considered to be **negligible**, particularly given the relatively limited loss of a burrowing and feeding resource.

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 event 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 Tideway. 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 impact magnitude.

Algae

Loss of habitat due to temporary landtake

5.5.46 The construction of a temporary cofferdam 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 temporary cofferdam, 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. 5.5.35, 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 cofferdam 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 in Section 5.5. This is because there are no developments in the site development schedule (Vol 18 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.5.4.57 - 5.4.60.

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

5.6.2 There would be approximately 5575m^2 of permanent landtake, of which approximately 750m^2 would be from the intertidal habitats close to Blackfriars Bridge. The permanent foreshore structure would extend approximately 35m into the channel at its maximum extent. Permanent landtake is certain and is considered to be a medium negative impact, due to the extent of landtake involved and the fact that Blackfriars Bridge Foreshore site falls within the non-statutory River Thames and Tidal Tributaries SINC (Grade M), and also includes areas of *BAP* habitat, including gravel foreshore and sublittoral sand and gravels.

Modification of habitat as a result of scour protection measures

5.6.3 As noted above, the outfall at Blackfriars Bridge Foreshore site 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 structure. Scour protection (including aprons) would comprise buried rip rap. A total area of up to 970m^2 is likely to be affected by scour protection at the Blackfriars Bridge Foreshore site.

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

Dredging for operation of the relocated Blackfriars Millennium Pier

5.6.5 There would be operational dredging of approximately 800m^3 to enable boats to use the relocated Blackfriars Millennium Pier. This would result in a small loss of subtidal mudflat habitat. The subtidal mudflat in these pockets would therefore be at a slightly lower depth than is currently the case. The area and depth of dredge is small in comparison to the total landtake at this site, and the effects of dredging already occur at the current location of the Blackfriars Millennium Pier. This is therefore considered a negligible impact on the intertidal and subtidal habitats and associated flora and fauna, despite being both certain and permanent.

5.6.6 Dredging associated with the operation of the relocated Blackfriars Millennium Pier (to ensure that it can be used by boats) is likely to lead to localised increases in suspended sediment with the potential to affect local and downstream habitats. However, despite the re-location, the dredging operation would be as currently carried out for the existing Blackfriars Millennium Pier. Impacts on the intertidal and subtidal habitats and associated flora and fauna are considered to be negligible, probable and temporary (since they would only occur when the dredge is taking place).

Shading of the river

5.6.7 The creation of a new piled landing stage, pier/pedestrian ramp and pontoon for the Millennium Pier would create permanent shading over an area of approximately 650m^2. Shading would alter the physical environment of intertidal and shallow subtidal sediments through reducing light availability, as well as reducing warming effects of sunlight. This in turn, would be reflected in a different community of algae and invertebrates adapted to such environments. However, the Blackfriars Millennium Pier is an existing feature so there would be no net increase in shading. There is relatively little intertidal habitat in the vicinity of Blackfriars Bridge and none of it consists of emergent vegetation (such as saltmarsh) that would be potentially very susceptible to shading. Most of the area covered by the landing stage and pontoon in the new location would be subtidal and thus subject to some degree of shading at all times. Further small amounts of localised shading could provide shelter to fish from predators, such as birds, through making them less visible. Overall therefore the impact is considered to be negligible, despite being both certain and permanent.

Change to scour and accretion patterns

5.6.8 The permanent foreshore structure would extend approximately 35m into the channel. Hydraulic modelling has shown that the permanent foreshore structure would impact on scour patterns.

5.6.9 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.

5.6.10 Approximately 970m^2 (260m^2 from intertidal and 710m^2 from subtidal habitat) would be associated with a permanent CSO outfall apron that would consist of buried rip rap which would be overlaid with an appropriate substrate material)

5.6.11 With the permanent structure in place, some sediment accumulation is predicted to occur in the subtidal zone immediately upstream and the intertidal zone immediately downstream of the permanent foreshore structure within the intertidal zone. These predicted areas of sediment and accumulation are illustrated in Section 14 of this volume.

5.6.12 Impacts on the intertidal and subtidal habitats and associated flora and fauna as a result of scour 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. Impacts due to accretion are considered to be negligible, probable and permanent.

Change to flow velocity

5.6.13 The presence of the permanent foreshore structure would result in alterations to the hydraulic regime. On both mean and maximum spring tides, maximum velocities are predicted to increase by 1% on normal fluvial flows. The impact is considered to be low negative.

Increases in dissolved oxygen concentrations in the vicinity of the CSO

5.6.14 The projected Typical Year 94% decrease in the volume of discharges compared against the base case (see para. 5.2.7a) 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. Thames Tideway Tunnel project improvements would ensure compliance with the DO standards described in para. 5.4.27. 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 Fleet Main CSO, and impacts would be near certain and permanent.

Reduction in sediment nutrient levels

5.6.15 Elevated concentrations of nutrients (phosphate and nitrate) are likely to have accumulated in the sediments in proximity to the existing CSO discharge point as a result of the faecal material and sewage derived litter discharged from the CSO. 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 CSO 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

5.6.16 Sewage derived litter from the CSO can be expected to reduce by approximately 94%, from approximately 144t to approximately 9t, in the Typical Year with beneficial effects on aquatic ecology receptors.

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

Operational effects

5.6.18 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.

5.6.19 Unless stated the effects described below apply to both Year 1 of operation and Year 6 of operation.

Designations and habitats

Permanent loss of habitats

5.6.20 There would be a permanent loss of approximately 4604 m^2 of mostly subtidal habitat due to the permanent structure. A further 967m2 (880m2 from subtidal and 150m^2 from intertidal 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-high (metropolitan) value of the receptor.

Shading of the river

5.6.21 Although there would be limited shading, the high sediment loading of the tidal Thames in this area and the fact that there would be no net increase in the extent of shading mean that there would a **negligible** effect, based upon a negligible impact on a receptor of medium-high (metropolitan) value. Moreover any shading impacts would be offset by the other qualitative improvements to the river.

Improvements in habitat quality through changes in water quality

5.6.22 The predicted increases in DO concentrations and reductions in organic material and sewage derived litter would result in localised improvements in habitat quality. This may be characterised by increased levels of photosynthesis by microscopic algae within the water column, 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-high (metropolitan) value of the receptor and the low positive impact magnitude.

Change in intertidal and subtidal habitat due to accretion

5.6.23 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 **negligible**, given the medium-high (metropolitan) value of the receptor and negligible impact.

Marine mammals

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

5.6.24 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 **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

5.6.25 The site is not considered to offer suitable spawning habitat for fish species. Loss of 4605m^2 of intertidal foreshore habitat is considered to be a medium negative impact. Given that the value of the receptor is medium (borough), the effect of permanent landtake on fish is considered to be **minor adverse**.

Modification of intertidal feeding and subtidal habitat for fish

5.6.26 At Blackfriars Bridge Foreshore site, scour protection would occupy an area of 970m^2. The rip rap scour protection, which would consist of rip-rap overlain with an appropriate substrate material 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)[23].

5.6.27 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.

5.6.1 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

5.6.2 The modelling results have predicted some changes in sediment accumulation 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 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. Therefore overall the effect of accretion is considered to be **negligible**, given the medium (borough) value of the receptor and negligible magnitude of impact.

Interference with migratory movements of fish

5.6.3 The Individual Based Modelling study shows that a large gyre or eddie forms on the flood tide between Blackfriars and Millennium Bridge. The study found that of the three species (bass, eel and flounder) used to represent the range of species found in the tidal Thames flounder were unable to swim out of the gyre during the flood tide because of their low swimming speed. None of the other species were affected. Flounder were able to continue their migration once current velocities reduce and the gyre dissipates. Despite this delay in upstream migration cause by the permanent works at the Blackfriars Bridge Foreshore site, there was no significant difference between the time taken to undertake an upriver migration (taken as the distance from 1.5km west of the Thames Barrier to

Putney Embankment Foreshore site) for the base case and the proposed development. This is likely to be because the structures offer refuges for juvenile fish against adverse currents, and thus they are able to make the remainder of the migration more rapidly. The effect is therefore considered to be **negligible**, given the medium (borough) value of the receptor and the low negative impact magnitude.

Reduction in the occurrence of dissolved oxygen related fish mortalities

5.6.4 Interception of the CSOs throughout the tidal Thames would result in far fewer hypoxia events. The Tideway Fish Risk Model 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 Tideway fish populations would become sustainable (i.e., less than 10% mortality as a result of hypoxia (Turnpenny *et al*, 2004)[24]), 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).

5.6.5 Interception of the Fleet Main CSO would contribute to tidal Thames-wide improvement, but would also result in improvements in the local area. Given that the impact is considered to be medium positive, and the value of the receptors is medium (borough) at this stage the effect is considered to be **minor beneficial**.

Increase in the distribution of pollution sensitive fish species

5.6.6 The tidal Thames currently supports a small number of rare fish species such as salmon, sea trout, twaite shad and river lamprey (*Lampetra fluviatilis*). A number of factors limit the colonisation of habitats by these species, and those relevant at Blackfriars include salinity, substrate type and current, and also pollution, which is known to be an important factor in determining colonisation (Maitland and Hatton-Ellis, 2003)[25]. 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.

5.6.7 EA data and bespoke project surveys have indicated no records of rare fish species in the vicinity of Blackfriars Bridge Foreshore site 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 and lead to increased current velocities. 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 species to colonise.

Improvement in the quality of foraging habitat

5.6.8 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. 5.6.22 and the invertebrate community becomes more diverse (para. 5.6.15 to 5.6.20) 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

5.6.9 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

5.6.10 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.

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

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

Change to burrowing and feeding habitat due to accretion

5.6.13 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 negligible impact.

Blanketing of feeding areas for invertebrates by suspended sediment

5.6.14 No sensitive, filter feeding invertebrates have been recorded in the vicinity of the site. Dredging operations already take place at the existing Blackfriars Millennium Pier, and there are high background levels of suspended sediment. The effect of periodic dredging to maintain a relocated Blackfriars Millennium Pier is considered to be **negligible** based on a receptor of medium (borough) value and a low negative impact.

Localised improvements in invertebrate diversity and abundance

5.6.15 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 would 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 brackish zone would continue to be suppressed.

5.6.16 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 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.

5.6.17 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)[26].

5.6.18 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** at Year 1 and **minor beneficial** at Year 6, as it would take time for new species to colonise.

Increase in the distribution of pollution sensitive invertebrate species

5.6.19 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.

5.6.20 EA data and bespoke project surveys have indicated one species of nationally rare (RDB) invertebrate, the mudshrimp (*A.lacustre*), present in the vicinity of Blackfriars Bridge Foreshore site but this is locally very common, and habitat quality at this site is limited by a number of factors including the confinement of the river channel between vertical river walls. 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.

Algae

Permanent loss of original river wall

5.6.21 The algae that have previously been found on the river wall at the Blackfriars Bridge 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 five years). As none of these species are uncommon the effect is considered to be **negligible**, given the low-medium (local) value of the receptor and the impact magnitude.

Changes in algal communities

5.6.22 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.

5.6.23 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**, given the low-medium (local) value of the receptor and the low positive impact magnitude.

Sensitivity test for programme delay

5.6.24 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 (Section 5.6). The base case conditions for Year 1 and Year 6 of the operational assessment would be likely to remain as described in paras.5.4.62 - 5.4.65.

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 18 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 Blackfriars Bridge 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 during construction and operation would remain unchanged. As described above in para. 5.7.1 - 5.7.3, there are no schemes anticipated to generate cumulative effects on aquatic ecology 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 Biodiversity Working Group and EA Technical 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' would be strictly applied in this sequence. 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. No other significant effects requiring mitigation are predicted during the construction stage.

5.8.4 During operation 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 on-site is not possible.

5.8.5 The permanent loss of habitat at the Blackfriars Bridge site contributes to an overall loss arising from all of the foreshore sites. Compensation for this project-wide permanent loss of foreshore habitat is described in Vol 3 Section 5 (see para. 5.9.2).

5.8.6 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

5.8.7 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 permanent 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 creation/ enhancement of sites along the route of the Thames Tideway Tunnel project to compensate for adverse effects on aquatic ecology. The loss of habitat at Blackfriars Bridge 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 18 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	Minor adverse	None	Minor 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
	Interference with migratory movements of fish	Negligible	None	Negligible
	Effect of waterborne noise and vibration on fish	Negligible	None	Negligible
	Reduction in water column visibility due to suspended sediment	Negligible	None	Negligible
Invertebrates	Direct mortality of invertebrates due to temporary landtake and disturbance and consolidation of sediment.	Negligible	None	Negligible

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
	Loss of feeding/burrowing habitat for invertebrates due to landtake	Negligible	None	Negligible
	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 an increase in water column turbidity due to suspended sediment	Negligible	None	Negligible

Vol 18 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 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.

Receptor	Effect	Significance of effect		Mitigation	Significance of residual effect	Compensation
		Year 1	Year 6			
	Shading of the river	Negligible	Negligible	None	Negligible	None
	Improvements in habitat quality through changes in water quality	Negligible	Minor beneficial	None	Minor beneficial	None
	Change in intertidal and subtidal habitat due to accretion	Negligible	Negligible	None	Negligible	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	Negligible	None	Negligible	None
	Change in feeding, resting and nursery habitat for fish due to accretion	Negligible	Negligible	None	Negligible	None
	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
	Improvement in the quality of foraging habitat	Negligible	Minor beneficial	None	Minor beneficial	None

Receptor	Effect	Significance of effect		Mitigation	Significance of residual effect	Compensation
		Year 1	Year 6			
Invertebrates	Permanent loss of intertidal feeding and burrowing habitat for invertebrates due to landtake.	Minor adverse	Minor adverse	None	Minor adverse	None
	Modification of intertidal feeding and subtidal habitat for invertebrates by scour protection	Minor adverse	Minor adverse	None	Minor adverse	None
	Change to burrowing and feeding habitat due to accretion	Negligible	Negligible	None	Negligible	None
	Blanketing of feeding areas for invertebrates by suspended sediment	Negligible	Negligible	None	Negligible	None
	Localised improvements in invertebrate diversity and abundance.	Negligible	Minor beneficial	None	Minor beneficial	None
	Increase in the distribution of pollution sensitive invertebrate species.	Negligible	Minor beneficial	None	Minor beneficial	None
Algae	Permanent loss of original river wall	Negligible	Negligible	None	Negligible	None
	Changes in algal communities	Negligible	Negligible	None	Negligible	None

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.18**

Volume 18 Blackfriars Bridge Foreshore site assessment

Section 6: Ecology - terrestrial

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

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Thames Tideway Tunnel

Environmental Statement

Volume 18: Blackfriars Bridge Foreshore site assessment

Section 6: Ecology – terrestrial

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6 Ecology – terrestrial

6.1 Introduction

6.1.1 Construction and operational effects for terrestrial ecology at Blackfriars Bridge Foreshore site have been scoped out. This is on the basis that no significant adverse effects on terrestrial ecology are anticipated during either construction or operation, as there are no notable species or habitats known to be present, or the potential for them to be present, on or adjacent to the site.

6.1.2 This section nevertheless presents details of engagement, baseline information and an overview of the reasons why this topic has been scoped out.

6.1.3 Likely significant effects on aquatic ecology are reported in Section 5 of this volume.

6.1.4 Plans of the proposed development as well as figures included in the assessment for this site are contained in a separate volume (Vol 18 Blackfriars Bridge Foreshore Figures).

6.2 Engagement

6.2.1 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 terrestrial ecology are presented in Vol 18 Table 6.2.1. The construction and operational assessment for this site was scoped out as part of scoping.

Vol 18 Table 6.2.1 Terrestrial ecology – stakeholder engagement

Organisation	Comment	Response
Environment Agency (Section 48 consultation response, October 2012)	Para 17.3.6 It is unlikely that any foreshore will remain at this site as a result of these works. This large encroachment creates a significant loss of this habitat in this area. There is no mention of the impact of the relocated River Bus pier on the more extensive areas of foreshore downstream of Blackfriars Bridge. This will all need to be quantified in the *Environmental Statement*	There is no notable foreshore habitat for wintering birds on or immediately adjacent to the site. This habitat is not considered to be important for wintering birds. The effects of foreshore loss on aquatic ecology receptors are assessed in Section 5 Aquatic Ecology.

Organisation	Comment	Response
	and suitable mitigation or compensation proposed.	
City of London – Planning and Transport Committee (Section 48 consultation response, October 2012)	The environmental information report states that the proposals would not have significant effects on aquatic or terrestrial ecology. Nonetheless every effort should be made to ensure that the encroachment of the new structures into the river and the relocated Blackfriars Pier create minimal impacts on the environment, of the river.	Comment is noted.
	In response to the stage two consultation it was recommended that further measures to improve the biodiversity value of the newly created open space should be proposed along with mitigation and monitoring of the local impact of this development on the biodiversity of the Thames at Blackfriars. The current proposals do make reference to incorporating these measures.	Replacement planting is proposed at this site. Additional features would be incorporated as part of the landscape scheme, which have benefit for biodiversity in line with the landscape and architectural design principles.

6.3 Baseline

6.3.1 The River Thames and Tidal Tributaries Site of Importance for Nature Conservation (SINC Grade III of Metropolitan importance[i]) is included in the aquatic ecology assessment in Section 5 of this volume. There are three designated sites relevant to terrestrial ecology within 250m of the

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

proposed development (Vol 18 Figure 6.4.1, see separate volume of figures):

a. Temple Gardens SINC (Grade B[ii]) approximately 50m to the north of the proposed development site.

b. Middle Temple Garden (Westminster Section) SINC (Grade B) approximately 50m to the north of the proposed development site.

c. Victoria Embankment Gardens: Temple Section SINC (Grade L[iii]) approximately 150m to the northwest of the proposed development site.

6.3.2 These sites are separated from the proposed development site by roads and other urban development. It is considered unlikely that works associated with construction or operation at the Blackfriars Bridge Foreshore site would affect these designated sites. There are no other designated sites within 250m of the site that could be affected by construction or operation at the Blackfriars Bridge Foreshore site.

6.3.3 A Phase 1 Habitat Survey (Vol 18 Figure 6.4.2, see separate volume of figures) identified that habitat is limited to hardstanding and semi-mature London plane (*Acer platanus x acerifolia*) trees. One of these trees would be removed. The hardstanding has negligible biodiversity value. The semi-mature trees have low intrinsic biodiversity value and would support only small numbers of nesting common bird species.

6.3.4 For the purposes of the *Environmental Statement* wintering birds are considered as a terrestrial species. There is no notable foreshore habitat for wintering birds on or immediately adjacent to the site. A narrow strip of foreshore is exposed at the lowest seasonal tides and therefore this habitat is not considered to be important for wintering birds.

6.4 Overview

6.4.1 It is confirmed that there is no potential for likely significant effects on terrestrial ecology arising from the construction or operation of the proposed development at Blackfriars Bridge Foreshore as the site comprises habitats of limited ecological value and therefore the proposed development is unlikely to result in significant adverse effects on notable species.

6.4.2 Replacement tree planting would be provided for the tree to be removed during works at Blackfriars Bridge Foreshore. Trees to be planted would be semi-mature London Plane.

6.4.3 In the unlikely event that sensitive receptors are found on site during construction, such as nesting birds, management measures in line with the

[ii] SINC (Grade B) = Site of Importance for Nature Conservation (Grade II of Borough importance)

[iii] SINC (Grade L) = Site of Importance for Nature Conservation (Grade I of local importance)

Code of Construction Practice (*CoCP*)[iv] would be implemented in conjunction with the contractors' site specific *Ecological and Landscape Management Plan*.

6.4.4 In the event that the programme for the Thames Tideway Tunnel project is delayed by approximately one year, it is not anticipated that the ecological value of the site described in Section 6.3 would change and therefore this site would remain scoped out.

[iv] 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).

Thames Tideway Tunnel
Thames Water Utilities Limited

Thames Water

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.18**

Volume 18 Blackfriars Bridge Foreshore site assessment

Section 7: Historic environment

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 18: Blackfriars Bridge 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 Blackfriars Bridge 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 buried 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 The construction assessment includes an assessment of the effects of ground movement (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 Volume 3 Project wide effects.

7.1.3 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 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 at listed buildings requiring offsite mitigation. Such effects are therefore not considered further in this assessment.

7.1.5 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 unlikely that archaeological remains would be present. A separate but related assessment of effects on townscape character and visual amenity is included in Section 11 Townscape and visual.

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 effects of the proposed development on the significance of heritage assets are clearly detailed in line with the requirements of the NPS. The role of the design process in helping to minimise adverse 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 Plans of the proposed development as well as figures included in the assessment for this site are contained in a separate volume (Volume 18 Blackfriars Bridge Foreshore Figures).

7.1.8 The site comprises two parcels of land: the 'main site' and the 'Blackfriars Pier site' to the east, so called because the current Blackfriars Millennium Pier would be relocated there. Together they are collectively referred to here as 'the site'.

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 Blackfriars Bridge and the listed river wall would cause ground movement that could potentially induce damage to the listed building. These are described below.

Demolition and temporary removal of structures

7.2.3 The President ship would be temporarily moved to the Chrysanthemum Pier at the western end of the main site, which would require some modification to the floating pontoon at this pier, and the existing mooring including access brows, bank seats and gangways would be removed (as shown on the Demolition and Site Clearance plans). The existing mooring would subsequently be reinstated and the ship would located back into its original position.

7.2.4 The part of the Thames Path that slopes down from the river wall adjacent to the Blackfriars Millennium Pier to the area beneath the Blackfriars Bridge and St Paul's Walk would be demolished. Part of the 1960s river wall parapet to either side of the access ramp to the Blackfriars Millennium Pier would be demolished, along with the former mid-20th century former London Fire Brigade Pumphouse (currently used as an office by Crown River Cruises), dolphin and access platform and modern concrete ramp and steps. These works are shown on the Demolition and Site Clearance plans for this site.

7.2.5 The stone parapet of the embankment wall (adjacent to the Blackfriars Millennium Pier), which comprises part of the Grade II listed embankment wall, would be removed. Two Grade II listed sturgeon lamp standards in the western part of the site would be removed and one would be subsequently reinstated as found. Three more sturgeon lamp standards adjacent to the access ramp and steps to the Blackfriars Millennium Pier would also be temporarily removed and reinstated. Three Grade II listed benches in the western part of the site would also be removed and later reinstated. These works are shown on the Demolition and Site Clearance plans for this site.

7.2.6 Part of a brick and mass concrete services subway, low level sewer and granite river wall facing adjacent to the Blackfriars Millennium Pier would be removed and subsequently reinstated, as shown on the Demolition and Site Clearance plans.

7.2.7 The following plans show the extent of listed structures within the LLAU, the extent of permanent and temporary loss and the way in which Thames Tideway Tunnel structures would interface with listed structures (see separate volume of figures - Section 1):

a. As existing site features plans 1-3 (show extent of listed structures within the LLAU, the extent of permanent and temporary loss)
b. Extent of loss of listed river wall plans 1 -2
c. As existing listed structure interface - river wall
d. Proposed listed structure interface - river wall
e. As existing listed structure interface - bridge stairs (west and east)
f. Proposed listed structure interface - bridge stairs (west and east)

Site setup and construction works

7.2.8 Welfare facilities would be constructed in the area of the existing underpass west of Blackfriars Bridge, and a permanent lift installed on the east side of the bridge. The lift would be set on foundations with a depth of up to approximately 1.0m deep, as assumed for the purposes of this assessment. An overflow weir chamber, which would be required to take sewage from the existing low level Bazalgette sewer to the CSO shaft, would be built on the landward side of the riverwall within the western zone within which all permanent site structures would be located (see Construction phases 1–3 plans and Site works parameter plan, separate volume of figures - Section 1).

7.2.9 A temporary cofferdam would be constructed, using sheet piling and granular infill, to provide a working area. For structural reasons, soft material located adjacent to the perimeter of the temporary cofferdam 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 cofferdam would remain *in situ*. Removal of the soft 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. 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 10.0m as assumed for the purposes of this assessment. Suitable sized plant would be utilised to reduce potential load impacts on the foreshore.

7.2.10 A piling rig, located on a jack up barge positioned on the foreshore, would be used to construct the cofferdam. The cofferdam would be inserted into slots within the listed and unlisted sections of the river wall. Barges would moor against a temporary deck on steel piles to allow the removal of excavated material via barges, as shown on the Construction phase 1 and 2 plans (see separate volume of figures - Section 1).

7.2.11 A temporary steel deck would be constructed on the foreshore adjacent to the western end of the temporary cofferdam to provide additional space for welfare and office facilities. The deck would be supported on steel piles driven into the foreshore (see Construction phases 1–3 plans, separate volume of figures - Section 1).

7.2.12 Within the temporary cofferdam, a permanent foreshore structure would be constructed adjacent to the embankment, and joined to listed and unlisted sections of the river wall via slots cut into the river wall. The area of the foreshore where permanent scour protection is required would be excavated to a depth of approximately 1.5m by an excavator. A new outfall apron would be constructed, in the form of 1.0m depth of stone placed up to 0.5m below the existing foreshore level, as assumed for the purposes of this assessment.

7.2.13 An electrical and control kiosk would be incorporated into the line of the 1960s unlisted river wall (within the zone shown on Site works parameter plan, see separate volume of figures - Section 1), a second kiosk would be located under the bridge ramp (see zone shown on Site works parameter plan, separate volume of figures - Section 1). Plane trees would be planted along the existing pedestrian ramp. Permanent below-ground structures within the permanent foreshore structure would include deep excavations for the construction of a combined sewer overflow (CSO) shaft, a connection culvert to the Fleet Main CSO outfall, an overflow weir chamber, an air treatment chamber, valve chambers, and connection culverts (see Site works parameter plan, separate volume of figures - Section 1). A stair structure would be constructed out from the existing river wall up to bridge level on the eastern side of Blackfriars Bridge. Its foundations and construction would not entail any ground disturbance on the foreshore or at the base of the river wall.

7.2.14 Piles would be driven to support the toe of the existing embankment wall. It is also assumed for the purposes of this assessment that bored piles would be used to support the culverts and overflow weir, located in the area of the river wall parapet adjacent to the Blackfriars Millennium Pier. Piling to reinforce the embankment wall and support the culverts and overflow weir would be carried out prior to the construction of other permanent below-ground structures within the cofferdam.

Relocation of Blackfriars Millennium Pier

7.2.15 Dredging of the foreshore within the Blackfriars Pier site would be necessary in the area of the proposed relocated Blackfriars Millennium Pier, which would remove all soft deposits within the dredged area.

7.2.16 The proposed new landing stage for the Blackfriars Pier would be constructed on stabilising piles driven into the foreshore, using a jack up barge.

7.2.17 Works at the Blackfriars Pier site are shown on the Construction phase plans for this site (see separate volume of figures - Section 1).

Construction activities relevant to historic character, appearance and setting of heritage assets

7.2.18 The specific construction activities which may give rise to effects on the historic character, appearance and setting of heritage assets are:

a. establishment of hoardings around the boundary of the construction site

b. use of cranes and other plant during shaft construction sinking and secondary lining

c. provision of welfare facilities

d. lighting of the site when required

e. removal of lamps.

Code of Construction Practice

7.2.19 Measures incorporated into the *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 would 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 would 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.

7.2.20 The *CoCP* is provided in Vol 1 Appendix A. It contains general requirements (Part A), and site specific requirements for this site (Part B).

7.2.21 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 any significant 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.

7.2.22 Site-specific measures incorporated in the *CoCP* Part B (Section 12) comprise:

a. Contractors working methods would minimise risk of accidental striking of the listed bridge. Protection barriers would be installed as required but not attached to the structure unless otherwise agreed.

b. During construction of the Blackfriars underpass work a Roman boat was uncovered in the cofferdam. The location is between the road and rail bridges. The Contractors method for the river works would minimise the risk of impact on the boat location by selecting suitable river plant and operating procedures.

c. The sturgeon lamp standards would be carefully removed, stored and reinstated in their current positions as far as it is possible. The existing replica lamp standards would be replaced with originals from elsewhere (by agreement) or new castings from the original moulds if possible.

d. Existing granite blocks would be used to make up the joint between new and old river wall sections

7.2.23 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

7.2.24 The operation of the proposed development at Blackfriars Bridge Foreshore site is described in Section 3. The particular components of importance to this topic include the scale of the foreshore structure, design of the public realm and the design and siting of the proposed ventilation structure and electrical kiosk. The location of these elements is illustrated in the Site works parameter plan (see separate volume of figures - Section 1).

7.2.25 The following plans show the design intent for above ground structures at this site (see separate volume of figures - Section 1):

a. Kiosk and undercroft design intent

b. Amenity kiosk design intent

c. Typical river wall design intent plans 1-2

d. Permanent President mooring access and plan elevation

7.2.26 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 that has been assessed. Alternatives to the proposed development, including design iterations, are fully detailed in Section 3 of this volume.

Historic environment design measures

7.2.27 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 heritage design principles. These aim 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.

b. Principles for the integration of functional components relevant to this site including those relating to materials, the use of signature designs and careful detailing because they would inform the appearance of the completed operational infrastructure.

c. Riparian and in-river structure principles relevant to this site including those regarding appearance and functionality.

d. All the landscape principles relevant to this site including those addressing the quality of soft and hard landscaping, materials and public accessibility.

7.2.28 All the lighting design principles regarding heritage and sensitive settings are relevant. These include matters relating to safety, the aesthetic effect of the lighting and the quality of fittings.

7.2.29 The following site-specific design principles are also relevant:

a. The festoon lighting to Victoria Embankment would be reinstated as far as possible.

b. Access ramps for the President moorings would be designed to current standards. They would bridge over the river wall with minimum physical or visual impact on the listed structure or span from the elevated platform at the western end of the new foreshore structure.

c. The majority of electrical and control equipment would be located in the undercroft area. A smaller kiosk would be located closer to the shaft within the line of the existing river wall for equipment that must be located close to the shaft.

d. Voids below the ramp (both existing and proposed) would be enclosed with high quality screens designed to be in keeping with the overall architectural and landscape design. Entrances to the main electrical and control equipment kiosk, WCs and specialist sports facility would be integrated into this screen.

e. The handrail that runs from the western Blackfriars Bridge parapet to the off ramp from Blackfriars Bridge to Victoria Embankment would be replaced to tie in with the new development. The fascia of the concrete edge beam would also be re-clad.

f. The western end of the foreshore structure would be raised above the current flood defence level to create a viewing platform.

g. The proposed railings to the western end of the foreshore area would be designed to be as visually unobtrusive as possible without compromising safety.

h. The existing sturgeon lamp standards would be carefully removed, stored and reinstated in their current position as far as possible.

i. The design would respect the views from the river to the listed buildings along Victoria Embankment and St Paul's Cathedral beyond.

j. Trees planted on the existing embankment would be semi-mature London Planes.

k. The foreshore structure would be planted with additional smaller trees to provide shade and improve microclimate.

l. The foreshore structure walls would be finished in natural stone.

m. Paving materials for areas of public realm would be of natural stone.

n. The Lions Heads on the river wall would be incorporated into the design where possible.

o. The pump house would be removed and not replaced.

p. The existing break in the parapet wall of Blackfriars Road Bridge would be used to accommodate replacement stairs and a new lift to the eastern side of the bridge. The western replacement stairs would be positioned to end in the zone of modern additions to the bridge. Both would be designed to respect the historic character and fabric of the bridge.

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 18 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 Westminster City Council. Consultation has highlighted important historic environment design considerations and helped to guide the design development.

7.3.3 It was recognised that the character of the river frontage at Blackfriars Embankment is significant and that the new foreshore structure should respect the primacy of the line of Bazalgette's river wall and its relationship with the embankment frontages of the listed buildings to the north. The 1960s embankment elements detract to an extent from the setting of the listed embankment wall and Blackfriars Bridge. Improving this relationship and reconciling the changes in level between these two significant elements was also a consideration in the development of the design. The foreshore structure was therefore designed to be subordinate to the bridge and in the final design the connecting staircases that would replace the existing 1960s staircases to the bridge, would be built to stand back from the significant elements of the bridge, to better reveal the bridge's significance and minimise intrusive connections to the structure. The decision to use granite cladding on the river frontage of the new pavement ramp that rises to the bridge, is also intended to improve the appearance of this area, replacing the 1960s concrete façade. The foreshore structure has also been designed to respect the primacy of the line of the river wall, and, as at Victoria Embankment Foreshore, shadow gaps have been introduced into the design of the foreshore structure to emphasise this.

Vol 18 Table 7.3.1 Historic environment – consultation response

Organisation and date	Comment	Response
English Heritage scoping opinion (January 2011)	The Greater London Historic Environment Record (GLHER) suggests the potential for material from the Dominican Friary and consequently a desk-based assessment of the foreshore and river archaeology in the development area is necessary.	Vol 18 Section 7 of the *Environmental Statement* sets out a thorough assessment of effects on all historic environment receptors. It takes into account the potential for medieval remains, including the friary.
City of London Corporation scoping opinion (May 2011)	The proposed methodology does not specifically mention the impact of the tunnelling activity on the historic bridges which span the Thames including Blackfriars Bridge (Listed Grade II).	The impact of tunnelling activity on all listed buildings (including listed bridges) along the route of Thames Tideway Tunnel is assessed in Vol 3. Effects from settlement on Blackfriars Bridge specifically are also presented in this site volume (Vol 18 Section 7.5).
City of London Corporation phase two consultation response (February 2012)	An assessment of buried archaeological remains is needed to assess the impact of the proposals and to inform mitigation. Where the proposed scheme would cause loss of listed heritage assets, such as part of Victoria Embankment and lamp standards, the incorporation and reuse of these features should be considered to maintain and protect their	Vol 18 Section 7 of the *Environmental Statement* sets out a thorough assessment of effects on all historic environment receptors. It includes effects on buried remains and on above ground listed heritage assets. Appropriate mitigation measures are detailed

Organisation and date	Comment	Response
	significance and to minimise impacts on the remaining structures, including their group value and important association with the river front.	in Section 7.8. Where possible materials removed by the works, such as lamp standards and granite cladding, would be used in the new structures.
	The proposals would affect above ground heritage assets including conservation areas, and their setting during temporary and permanent works, altering the form, design and structure of the river wall and the relationship of the land and foreshore. Construction into the river would extend the built form of the City in this area, leading to loss of the visual and physical impact of the tidal regime and exposed foreshore.	Vol 18 Section 7 of the *Environmental Statement* includes an assessment of effects on the character, appearance and setting of assets. Since the proposals consulted on during phase 2, the design of the permanent structure been improved to fit in better with both the river wall and Blackfriars Bridge.
	The proposed landing stage and floating pontoon to the east of Blackfriars Bridge would introduce structures on the foreshore and in the river which would affect archaeological remains in this area and may cause changes in the hydrodynamic regime leading to scouring or sediment deposition which may erode or obscure archaeological remains.	The assessment of effects presented in Vol 18 Section 7 of the *Environmental Statement* includes the effects of in-river structures on archaeology, including the effects of scour during construction, and how these would be mitigated. The operational design includes scour protection measures.
	The proposals would affect buried archaeological remains consisting of land reclamation, including structures, foreshore, river bed and environmental remains associated with the confluence of the rivers Fleet and	The assessment of effects includes all heritage receptors, including buried heritage associated with the confluence of the Fleet and Thames.

Organisation and date	Comment	Response
	Thames.	
English Heritage phase two consultation response (February 2012)	Need for mitigation and recording of the WW2 former London Fire Brigade Pumphouse.	Measures to mitigate effects on the former London Fire Brigade Pumphouse are detailed in Section 7.8 of this assessment.
	English Heritage support the proposed design solution subject to confirmation that it would not create an unacceptable increase in scour that would pose an unsustainable risk to the archaeology of the River Thames.	Once operational, scour protection around foreshore structures would prevent scour affecting heritage assets. In the deeper channel where contraction scour may occur it is very unlikely that archaeological remains would be present.
	English Heritage is content with the proposed treatment of foreshore archaeology at the site.	Noted.
	It is likely that the proposals would result in major adverse effects on the setting of multiple designated heritage assets during the construction phase. English Heritage expects these to be appropriately mitigated.	Vol 18 Section 7 of the *Environmental Statement* includes an assessment of effects on the character, appearance and setting of assets. Measures to minimise such effects have been designed into the scheme.
English Heritage Meeting to discuss field evaluation methodology and response to phase two consultation comments	Most of a Roman boat within the site was excavated in 1963; however, this did not include the bow of the ship. English Heritage suggested looking at historic photographs to inform understanding of existing conditions.	Baseline conditions are detailed in Vol 18 Section 7.4, and these include reference to the Roman boat. Likely significant effects on any remains have been assessed. Measures to protect any remains are included within the

Organisation and date	Comment	Response
(April 2012)		*CoCP* Part B (Section 12).
English Heritage section 48 consultation response (October 2012)	The ES would benefit from explaining that the design at this site is the result of rigorous design iterations to arrive at a form which is complementary to the historic environment in this location.	The design process, including consultation with stakeholders in relation to the historic environment, is set out in this assessment, and consideration of alternatives is also detailed in Vol 18 Section 3.
	English Heritage would welcome an explanation of why, in the assessment for this site, the historic environment impacts on some heritage assets differ from the townscape impacts.	Where these differences exist, the *Environmental Statement* includes an explanation in the assessment for each asset.
	English Heritage requests that the assessment refers to the international renown of this stretch of the Thames.	As discussed at a meeting with EH on 11th October 2012, it was agreed that the ES would continue to refer to this stretch of the Thames as being of national renown.
City of London Corporation Section 48 consultation response (October 2012)	The City of London Corporation noted that the proposal would affect the significance of a number of listed buildings located within and adjacent to the site, including their setting.	Vol 18 Section 7 of the *Environmental Statement* includes an assessment of physical effects and effects on the character, appearance and setting of assets. Measures to mitigate physical effects are detailed in Vol 18 Section 7.8, whilst measures to minimise effects on setting have been designed into the scheme.
	The proposals would affect a number of heritage assets and	As noted above Vol 18 Section 7 of the

Organisation and date	Comment	Response
	their settings during temporary works, construction and permanent works, which would alter the form, design and structure of the river wall and the relationship of the land and foreshore.	*Environmental Statement* includes an assessment of effects on the character, appearance and setting of assets.
	The proposals, and proposed landing stage and floating pontoon to the east of Blackfriars Bridge would introduce structures on the foreshore and in the river which may affect archaeological remains, including through changes to the hydrodynamic regime.	As noted above, the assessment of effects presented in Vol 18 Section 7 of the *Environmental Statement* includes the effects of in-river structures on archaeology, including the effects of scour during construction, and how these would be mitigated. The operational design includes scour protection measures.
	The City remains of the view that a full Historic Environment Assessment, including assessment of buried archaeological remains, is needed to assess the impact of the proposals and to inform appropriate mitigation. Where the proposed works would cause loss of listed heritage assets, such as part of the Victoria Embankment and lamp standards, the incorporation and reuse of these features should be considered.	Vol 18 Section 7 of the *Environmental Statement* sets out a thorough assessment of effects on all historic environment receptors. It includes effects on buried remains and on above ground listed heritage assets. Appropriate mitigation measures are detailed in Section 7.8. The *Design Principles* (Vol 1 Appendix B) set out the approach to minimising the loss of historic fabric and the approach to reinstating and reusing any historic assets removed through construction, such as

Organisation and date	Comment	Response
		lamp standards.

Baseline

7.3.4 The baseline methodology follows the methodology described in Vol 2. It should be noted that whilst most of the topics within the ES 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.

7.3.5 Baseline conditions for buried and above-ground assets are described within a 250m area around the centre points of the main site and the Blackfriars Pier 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, gravel eyots to the north of the site, where watermills were located in the Roman period. These can contribute to current understanding of the site and its environs in the Roman period.

7.3.6 The assessment area for the assessment of 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 development. The setting of these assets is then described in the baseline. Where appropriate this assessment area extends beyond the 250m radius around the centre of the site. 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 relevant conservation area appraisals and from professional judgement based on observation and understanding of historic context and architectural purpose and design.

7.3.7 Site visits were carried out in March 2011 to identify assets on or adjacent to the site. A further site visit was carried out in January 2012 to identify assets for inclusion within the assessment of effects on setting.

Construction

7.3.8 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.

7.3.9 In terms of physical effects on buried or above-ground 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, except in the case of ground movement, where the assessment area extends to cover listed buildings predicted to be affected by 1mm or more of ground movement.

7.3.10 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 in each assessment). The construction assessment area is described in para. 7.3.6.

7.3.11 Section 7.5 details the likely significant effects arising from the construction at the Blackfriars Bridge Foreshore site. In addition to these, the works proposed by the Thames Tideway Tunnel project at the Victoria Embankment Foreshore site would give rise to additional effects on the historic environment within the assessment area for this site. Therefore the combined effects of construction at Blackfriars Bridge Foreshore and Victoria Embankment Foreshore are considered in this assessment.

7.3.12 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. Furthermore none of the schemes included in the site development schedule (Vol 18 Appendix N) would lead to physical changes in buried or above-ground heritage assets within the site. Therefore any changes to the surrounding baseline would not affect the assessment and are not detailed further within the construction base case. 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 program of mitigation for other developments, such information is unlikely to significantly change the current understanding of the historic environment of the site, and is therefore not considered further in the base case.

7.3.13 None of the schemes included in the site development schedule (Vol 18 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.

7.3.14 The site development schedule (Vol 18 Appendix N) identifies no schemes for consideration in terms of cumulative effects. Therefore no assessment of cumulative effects has been undertaken.

7.3.15 The assessment of construction effects on the character, setting and appearance 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

7.3.16 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 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 assessment 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 in relation to each asset as appropriate). The operational assessment area is as described in para. 7.3.6.

7.3.17 As stated in para. 7.3.11, the proposed development at the Victoria Embankment Foreshore site would give rise to additional effects on the assessment of the historic environment at this site. Therefore the combined effects of the works at Blackfriars Bridge Foreshore and Victoria Embankment Foreshore are considered.

7.3.18 None of the schemes included in the site development schedule (Vol 18 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.

7.3.19 As all of the schemes set out in the site development schedule (Vol 18 Appendix N) would be completed and operational by the operational phase assessment year, there would be no cumulative effects on the historic character and setting of above-ground heritage assets.

7.3.20 The assessment of operational effects on the character, setting and appearance 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

7.3.21 The assumptions and limitations associated with this assessment are presented in Vol 2. Site-specific assumptions and limitations are detailed below.

Assumptions

7.3.22 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 any significant heritage assets would have been archaeologically excavated and recorded after insertion of the temporary cofferdam.

7.3.23 A number of assumptions have been made regarding the likely depth of temporary construction works (eg. footings for service trenches), 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.

7.3.24 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.

7.3.25 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.

7.3.26 Assumptions relating to the assessment of effects arising from ground movement are detailed in the project wide assessment in Vol 3 Section 7.

Limitations

7.3.27 A limitation of the assessment is that other than an excavation of part of a Roman boat in the northwestern corner of the main site, no intrusive archaeological investigation has been carried out on the site in the past. Nevertheless the assessment is considered to be robust and in accordance with best practice.

7.3.28 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 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 their historic character, appearance and setting.

Current baseline

Historic environment features

7.4.2 The historic environment features map (see Vol 18 Figure 7.4.1 in separate volume of figures) shows the location of known above-ground and buried historic environment features within the 250m 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 18 Appendix E.1.

7.4.3 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 in the 'Statement of significance: above-ground heritage assets' 7.4.48 to 7.4.71 in this section.

Designated assets

International and national designations

7.4.4 Bazalgette's Victoria Embankment wall is a Grade II listed structure (HEA 1A), although a section of the wall beside Blackfriars Bridge (HEA 1I), in the eastern part of the main site, constructed in the 1960s as part of the current pedestrian underpass, is not part of Bazalgette's construction and is unlisted (the extent of the listed river wall within the LLAU is shown in the As existing site features plans 1-3, see separate volume of figures - Section 1). The listed section includes Grade II listed cast iron lamp standards, a granite retaining wall, piers and stairs. Several of the listed iron lamp standards fall within the main site. It has been assumed that lamps that have been relocated onto the unlisted section of the 1960s parapet wall are also unlisted.

7.4.5 Five of 21 Grade II listed late 19th century benches with cast iron supports in the shape of crouching sphinxes and camels (HEA 72), located along the riverside pavement opposite Inner Temple Garden, are situated within the main site.

7.4.6 The President vessel (HEA 1C), moored in the centre of the main site, is listed on the National Register of Historic Vessels and is also a member of the National Historic Fleet (Cert No. 494). Although the ship is not statutorily protected she is considered by National Historic Ships (a non-departmental public body that advises the Secretary of State and other public bodies) as being of pre-eminent national or regional significance and is therefore included in the historic environment baseline (National Historic Ships UK website, 2011)[1].

7.4.7 Baynard's Castle (HEA 75) is a scheduled monument, located approximately 30m to the north of the Blackfriars Pier site, and comprises a medieval enclosure castle which survives as buried archaeological remains beneath modern development.

7.4.8 There are numerous other listed buildings within the baseline area (these are mapped in Vol 18 Figure 7.4.1 in separate volume of figures and described in Vol 18 Appendix E.1 Table E.1) and further described in the 'Statement of significance: above-ground heritage assets' 7.4.48 to 7.4.71 in this section.

Local authority designations

7.4.9 The site lies within the City of London, the entirety of which is designated as an archaeological priority area. It also lies within the southern boundary of the Whitefriars Conservation Area, characterised by a number of heritage assets within its boundaries, including the ancient confluence of the Thames and the Fleet, which was much wider than the current culverted Fleet sewer, and had an important commercial use until the latter part of the 18th century.

Known burial grounds

7.4.10 There are no known burial grounds within the site. There are former burial grounds present within the baseline area, including Bridewell Burial Ground (HEA 24), approximately 190m to the north, and an associated secondary burial ground approximately 160m to the northwest (outside the baseline area). A Saxon burial ground (HEA 108) has also been recorded beneath railway lines, approximately 160m to the northeast of the site.

Site location, topography and geology

7.4.11 The site is located on the north bank of the River Thames and includes the Victoria Embankment riverwall. The northern approach to Blackfriars Bridge (HEA 1I) lies within the main site. Underneath the bridgehead are outfall gates, which release water from the culverted subterranean Fleet, now the Fleet Main sewer (HEA 1F). The Blackfriars Millennium Pier, and the earlier former London Fire Brigade Pumphouse (HEA 1G), are located on the foreshore. The President ship (HEA 1C) is permanently moored to a pontoon (HEA 1M) within the western part of the site. The Blackfriars Pier site lies on an area of undeveloped foreshore and includes a section of the 1960s river wall within its northwestern boundary.

7.4.12 The majority of the foreshore within the main site lies submerged during high tide at approximately 100.0m ATD. Further into the river and eastwards, as far as the Blackfriars Millennium Pier (in the eastern part of the main site), it lies at approximately 94–95.5m ATD, rising slightly to 97.0m ATD beneath Blackfriars Bridge. On the Blackfriars Pier site, the riverbed drops from approximately 98.0m ATD at the northern end of the foreshore (adjacent to the river wall) to 94.0m ATD at the southern boundary of the site.

7.4.13 The site spans the confluence of the Fleet and Thames rivers. For much of its past, the site lay within the Thames channel, until the gradual extension of the riverfront from the Roman period onwards, and particularly in the post-medieval period, to its present location.

7.4.14 The site is on alluvium overlying bedrock geology of London Clay, with Taplow and Hackney gravel terraces capped by brickearth occurring on either side of the Fleet, approximately 250m to the north. Borehole data from the vicinity of the site on the landward side indicates the alluvium in the area can variably consist of sands, peats and gravels varying between 1.0m and 5.0m in thickness, below deposits of made ground.

7.4.15 Borehole data from the vicinity has allowed a transect to be constructed, encompassing the site, from which predictions can be made as to the types and depths of geology (and therefore potential depths of archaeology) within the site. A deep channel cuts through the London Clay to 90.4m ATD, approximately 100m north. This palaeochannel formed very early, probably in the late Pleistocene (the Late Upper Palaeolithic archaeological period), and is very rare for this area of London. The gravels rise steeply southwards to a high point 30m north of the main site at approximately 96.0m ATD, before sloping back downward toward the river. It is estimated that any gravels present within the site would lie at approximately 95.5m ATD.

7.4.16 Typically, late Pleistocene gravels are overlain by sands which become increasingly organic over the higher gravel area at approximately 96.5m to 97.5m ATD approximately 60m north of the site. This is indicative of river marginal environments or possibly soil horizons relating to the early prehistoric (Mesolithic). In the Roman period, the river levels fluctuated, reaching a high of approximately 101.0m ATD. In the area of the site, fluctuations in river levels are likely to have led to scouring by the Fleet and consequent truncation of the underlying sands during the Roman period. This is likely to have removed later prehistoric levels typically found to exist at 100.0m ATD in similar environments. Following the steady increase in river levels, surviving later medieval and post-medieval remains, as well as palaeoenvironmental evidence may be present within the grey silty clay alluvium.

7.4.17 The presence of made ground within the foreshore area of the site is expected to be minimal, other than a localised area under Blackfriars Bridge and to the east (the eastern half of the site) where there are concrete blocks. These were probably put in place to stop the foreshore eroding below the level of the river wall footings and north bridge pier. Vibro cores have confirmed that minimal foreshore gravels or made ground exists across the foreshore of the site, recording a thickness of approximately 0.4m. The surface of the underlying London Clay lies at approximately 95.1m ATD to the west, 95.0–95.4 ATD to the east, and approximately 92.9m ATD in the centre of the site. The lower London Clay in the central part of the foreshore area may relate to the former confluence of the Fleet and Thames Rivers, or to dredging activity in the area. The site topography and geology is discussed in more detail in Vol 18 Appendix E.2.

Past archaeological investigations

7.4.18 In the early 1960s a 1st century Roman ship containing building stone which would have been en route to Londinium (HEA 1B) was recovered from the then foreshore in the northeastern part of the main site. Sections of the northern part of the wreck were exposed and recorded at low tide in 1962 (see Vol 18 Appendix E.5, Plates E.1–E.5). In 1963, a cofferdam was built across the southern section of the wreck, which was then fully exposed and excavated, minus the tip of the bow, which was cut through by the cofferdam and may still be buried within the foreshore of the site.

7.4.19 Several excavations to the northeast of the main site, including HEA 3, 4, 6–8, and 11–15, have revealed extensive medieval and post-medieval land reclamation and revetment remains, as well as the remains of a medieval river wall, stairs and moorings, and post-medieval structural remains. At 9–12 Bridewell Place, approximately 180m to the north of the site (outside the baseline area), foundations of the 16th century Bridewell Palace was discovered.

7.4.20 The closest investigation to the Blackfriars Pier site was carried out at 223–225 Upper Thames Street, (HEA 61), approximately 30m to the northeast. It revealed four periods of medieval and post-medieval east-west river frontages. Excavations at Blackfriars Bridge Station (HEA 59) and the Mermaid Theatre (HEA 60), revealed riverine deposits and revetment timbers and remains of the Roman and medieval riverside walls, respectively. An excavation at Baynard’s Castle (HEA 62), approximately 40m to the northeast of the site, revealed the foundations of a 15th century castle with later phases, overlying earlier tenements and a public watergate. Other features associated with Baynard's Castle, such as its tower and gate, have also been recorded to the north and northeast of the site.

7.4.21 Numerous archaeological investigations to the north and northwest of the Blackfriars Pier site (HEA 61, 85, 90, 92, 96, 101, 104 and 108) have recorded evidence of Roman activity. Only two investigations around the Blackfriars Pier site (HEA 61 and 108), have recorded early medieval remains (the former structural remains and the latter a burial ground). To the northwest of the main site, other past investigations have recorded medieval (HEA 131, 137 and 139) and post-medieval (HEA 130 and 136) activity.

7.4.22 Within the baseline area on the foreshore to the east of the Blackfriars Pier site, three wrecks have been discovered. In 1962, a 17th century ship (HEA 100) was revealed adjacent to the eastern boundary of the Blackfriars Pier site. In 1970, two 15th century ships carrying Kentish ragstone (HEA 98 and 147) were discovered, approximately 70m and approximately 100m to the east of the Blackfriars Pier site.

7.4.23 Further details of past archaeological investigations carried out within the site and baseline area are included in Vol 18 Appendix E.3.

Archaeological and historical background of the site

7.4.24 The following section presents a chronological summary of the archaeological and historical background of the site. Further detail is included in Vol 18 Appendix E.4.

7.4.25 It is likely that throughout the prehistoric period (700,000 BC–AD 43), the site lay in an area which was largely submerged. The results of nearby boreholes suggest a bank of higher gravel (an eyot) may have existed approximately 100m to the north of the site. It is possible that this extended into the main site and may have been suitable for settlement. A late Neolithic or Bronze Age sword was discovered within the Thames Channel in the Blackfriars Pier site (HEA 1H) in the mid-20th century. Several isolated prehistoric artefacts, including handaxes and spears dating to the Neolithic and Bronze Ages (HEA 17, 18, 19, 64 and 127) have been recovered from within the Thames Channel, and to the north and northeast of the Blackfriars Pier site. It is possible that these artefacts represent activity on the shoreline in the Neolithic and Bronze Age periods; when river levels were lower than in later periods. A prehistoric lithic implement and human remains (HEA 107) were also recorded approximately 180m to the northwest of the Blackfriars Pier site.

7.4.26 Throughout the Roman period (AD 43–410), the site would have lain submerged within the Thames channel. By the late 1st century AD, revetments, quays, jetties and warehouses had been built along the waterfront in Londinium. The process of reclaiming land from the river and establishing waterfront structures continued throughout the 2nd and 3rd centuries. Contemporary evidence of the expansion of the Roman waterfront was discovered within the north-eastern corner part of the main site, in 1962, in the form of the remains of a 2nd century flat-bottomed barge (HEA 1B). It had sunk close to the confluence of the Thames and the River Fleet which may well have functioned as a mooring-place and harbour. The bottom of the vessel was uncovered at 96.4m ATD. River levels are believed to have fallen from approximately 102.0m ATD to 100.0m ATD in the early Roman period and then to have risen again in the 3rd or 4th century. Therefore the contemporary channel would have been approximately 3.6–5.0m deep at the point where the vessel sunk.

7.4.27 The main site lay approximately 80m to the southwest of the Roman city of Londinium, which was located on the eastern bank of the River Fleet, whilst the Blackfriars Pier site lay within the river just south of the city boundary. To the north of the Blackfriars Pier site, previous investigations have recorded evidence of Roman activity, including sections of Roman riverside walls, flood defences and piles (HEA 60–62, 66, and 101), and isolated tile and pottery on what would have been the Thames foreshore. Evidence of quarrying was recorded approximately 200m to the northeast (HEA 85 and 96); probably for the construction of buildings and roads. Roman re-deposited brickearth and gravel, along with pottery (HEA 90), was discovered approximately 175m to the north; rubbish pits (HEA 92), approximately 170m to the north; and a timber building (HEA 61) 30m to the northeast. Evidence of milling, quarrying and building activity on the gravel eyots of the east bank of the Fleet was also identified to the northeast of the main site.

7.4.28 Although the site continued to lie within the Thames channel and outside the settled areas in the early medieval (Saxon) period (AD 410–1066), there is evidence of peripheral activity on the riverbank to the north of the site. St. Bride’s Church, approximately 300m to the north of the main site, is likely to be of Saxon foundation and certainly existed by the 11th century, when it probably acquired its parish. A Saxon burial ground has been identified to the north of the site (HEA 108); a number of the burials showed signs of quartering or decapitation, suggesting a burial ground for criminals.

7.4.29 The site continued to lie within the River Thames in the later medieval period (AD 1066–1485), some distance south of the riverfront, although throughout this time the banks of the Thames were systematically drained and reclaimed, pushing the riverbank southwards, probably to a line approximately 100m north of the present river wall. Following the Norman Conquest in 1066, the defences of the city were rebuilt. Fortresses were established on the western city wall, at Baynard’s Castle (HEA 75), approximately 30m to the northeast of the Blackfriars Pier site (established by 1087), and at Montfichet’s Tower, approximately 100m to the northeast (established by 1136). In 1157, Henry II granted the Order of the Knights Templars land on the banks of the Fleet. They reclaimed large tracts on both sides of the river, narrowing its mouth. In 1276, the site of Baynard’s Castle (destroyed in 1213) was given to the Blackfriars (Dominicans) for a new religious precinct. The earliest occupation within the vicinity, however, was by the Carmelite Friary (Whitefriars) complex, established in c. 1250. Two previous investigations (HEA 89 and HEA 90), approximately 200m to the north of the Blackfriars Pier site, recorded the remains of the Kings Great Wardrobe; an office which provided clothing and textiles to the Royal Family. Next to this was a church, known as “St

Andrew's by the Wardrobe". The church was constructed during the later medieval period and its foundations (HEA 92) were recorded approximately 170m to the north. Most of the archaeological evidence for the later medieval period in the baseline area is of extensive land reclamation through infilling and the construction of river walls along the Thames riverfront (HEA 6, 7, 8, 12, 15, 96 and 106) and the Fleet valley.

7.4.30 The site remained within the Thames channel throughout much of the post-medieval period (AD 1485–present), although continued land reclamation from the 15th and 16th centuries onwards, for which extensive archaeological evidence has been uncovered, approximately 90m (HEA 4) and 130m (HEA 15) to the north of the main site, increased advancement of the waterfront towards the site. In the 15th century two ships were wrecked on the foreshore (HEA 98 and 147), approximately 70m and 100m to the east of the Blackfriars Pier site.

7.4.31 Historic, pre-Ordnance Survey, maps from the late 16th to the late 18th centuries (see Vol 18 Appendix E.5 Plates E.6–E.9) show rapid development in the construction of buildings and the beginnings of industrial and commercial use of the land to the north of the site, as the riverfront was reclaimed and extended southwards. In 1760, an earlier Blackfriars Bridge was built in the area occupied by the current bridge.

7.4.32 The City of London (Blackfriars) Gas Works (HEA 25) was constructed over a large area to the north of the main site in the early 19th century. By the mid-19th century the confluence of the Thames and Fleet had been entirely built over to create an approach over New Bridge Street (HEA 1F), whilst the river beneath was culverted to form the Fleet Main sewer that currently emerges beneath the northernmost arch of Blackfriars Bridge. The original Blackfriars Bridge was largely demolished and replaced with the current structure in 1869. The London, Dover and Chatham Railway, running across the Thames, to the east of the main site adjacent to the present railway bridge, was constructed in 1862.

7.4.33 The present riverfront of the Victoria Embankment was built by Sir Joseph Bazalgette in 1865–1870, as part of London's sewerage improvements. It necessitated building out onto the foreshore. A tunnel was also built for the Metropolitan District Railway within the embankment and roofed over to support the road and tramway adjacent to the river wall. Throughout the 19th century, the Blackfriars Pier site continued to lie partially submerged and partially on the foreshore, to the south of a row of wharfs.

7.4.34 In the 1940s, a pier, pump house (the former London Fire Brigade Pumphouse) (HEA 1G) and associated access ramps were built in the eastern part of the main site as emergency fire brigade measures during the Blitz. In the 1960s, the existing underpass and realigned river wall was constructed. The railway to the east was removed in 1985. In 2000, the Blackfriars Millennium Pier was built in the centre of the main site.

7.4.35 The majority of the foreshore within the main site is usually submerged beneath the River Thames. The eastern end of the main site, on which the northern approach to Blackfriars Bridge is situated, and the Blackfriars Pier site, lies above water level at low tide. During the site visit the truncated remains of round timbers (HEA 1B) were noted immediately adjacent to the Victoria Embankment river wall on an east-west alignment, exposed at low tide. These are likely to be post medieval and related to the cofferdam used in the construction of Bazalgette's river wall.

Statement of significance: buried heritage assets on the site

Introduction

7.4.36 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.

7.4.37 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

7.4.38 Archaeological survival potential across the site is generally likely to be high for post-medieval remains, but probably low to moderate for earlier periods due to fluvial erosion. The proximity of the Blackfriars Millennium Pier, Blackfriars Bridge and the outfall of the Fleet Main sewer are likely to have caused scour erosion, and concrete blocks have been placed around the bridge piers for scour protection. Scouring is likely to have removed any alluvial deposits predating the post-medieval period from within the foreshore area of the site.

7.4.39 There may be localised pockets of surviving alluvium, and earlier deposits, possibly within the central part of the main site, at a depth of up to approximately 0.0–4.5mbgl (95.5m ATD; the predicted level of natural gravels, if they survive). There may also be localised survival within the foreshore at the Blackfriars Pier site, where the extent of previous scouring is not known. Early structural remains and boats may also have survived erosion, as revealed by the discovery of the Roman ship within the northeastern part of the main site (see para. 7.4.18). Other factors affecting archaeological survival include:

a. The construction of the existing and earlier Blackfriars Bridges in the eastern part of the site would have entailed considerable ground disturbance, truncating any archaeological remains locally. The earlier bridge (constructed in 1760) probably had between four and ten deep timber piles to support each of its piers (Cross-Rudkin, 2006)[5]. The present bridge (constructed in 1869) used deep iron caissons to support piers for five arches. Cofferdams were used in the construction of the bridges, although the details of these are not known. This is likely to have damaged foreshore deposits.

b. The Blackfriars Millennium Pier in the centre of the site has two main stabilising piles of approximately 1.0m in diameter each at its river wall side. These would have removed any remains locally. The as-constructed drawings of the pier show that there are steel sheet piles on the shore-side of the pier and that the river bed in front of the piles has been dredged below the pontoon.

c. The site walkover survey identified the remains of what are assumed to be post-medieval wooden piles (HEA 1K), in the form of a single upright timber and two closely positioned round timbers, adjacent to the river wall in the centre of the northern boundary of the site. These may be the remains of the cofferdam used to construct the original embankment wall in the 1860s. It is probable that further piles are present. The piles would have had a localised impact on earlier remains (although they are also of heritage interest in themselves).

Asset potential and significance

7.4.40 The following statement of asset significance takes into account the levels of natural geology and the level and nature of later disturbance and truncation.

Palaeo-environment

7.4.41 The site has a low potential to contain palaeoenvironmental remains. Although the site is located on alluvial sand, lying beneath the River Thames at high tide and partially beneath it at low tide, fluvial scour is likely to have caused a high degree of erosion within the site and removed early palaeoenvironmental remains. Such remains, if present, would be of low or medium significance depending on their nature and degree of preservation. This would be derived from the evidential value of such remains.

Prehistoric

7.4.42 The site has an uncertain, probably low potential to contain prehistoric remains. It is likely that the site lay in an area which was largely submerged in much of the prehistoric period, although it is possible that areas of higher ground, including a known eyot to the north, may have extended into the site. Rising water levels are likely to have led to scour by the Fleet however, and truncation of the alluvium and sand and any prehistoric remains within or beneath. Re-deposited finds, (ie, finds deposited outside of their original context), would be of low significance.

Roman

7.4.43 The site has a moderate to high potential to contain Roman remains. The site was located in the river channel, around 150m to the south of the Roman riverbank, although the focus of riverfront activity lay to the northeast in the area of the city on the eastern side of the River Fleet. The find of a wrecked Roman ship suggests a potential for remains related to the movement of barges and ships at the mouth of the Fleet, including shipwrecks, shipbuilding materials or residual artefacts. The small remaining unexcavated prow-section of the Blackfriars Roman ship may survive within foreshore deposits and beneath concrete blocks of foreshore protection in the northeastern corner of the main site. Any further ship remains would potentially be of high significance. This would be derived from the evidential value of surviving remains. Isolated artefacts would be of low significance.

The setting of the Blackfriars Roman ship

7.4.44 The prow of the Blackfriars Roman ship, preserved *in situ* beneath the foreshore to the east of the proposed cofferdam, is not designated (ie, as a scheduled monument) but is nevertheless considered a known asset of high significance. The original setting of the asset would have been the River Thames channel close to the mouth of the Fleet valley, an area that would have been busy with shipping. The Roman city of *Londinium*, and its riverfront quays and warehouses lay to the northeast, set some way back from the current riverfront, which has been successively built out into the river channel over many centuries. The city wall extended along the eastern bank of the Fleet, with open fields beyond. The current setting of this buried asset is essentially unchanged in terms of its topographic and riverine context and it spatial relationship with the Roman city and the River Fleet (now entirely subterranean), and contributes the significance of the asset, although currently not to the way that the asset is experienced, as it is not visible. The setting can be considered to be of medium significance, in terms of the value of its contribution to the overall significance of this important asset.

Early medieval

7.4.45 The site has a low potential to contain early medieval remains. There are no known remains dating to this period within the site, which lay within the River Thames throughout this period, and the riverfront to the north does not appear to have been settled. Isolated artefacts, such as the Saxon coin and knife discovered on the foreshore between the main site and Blackfriars Pier site would be of low significance.

Later medieval

7.4.46 The site has a low potential to contain later medieval remains as it lay within the Thames throughout the period. There is evidence of land reclamation along the banks of the Thames and Fleet to the north, and whilst this extended the line of the waterfront towards the site, it still lay some distance away. As the site lay at the confluence of the Fleet, with the Friary complex on the riverbank adjacent, it is likely that the area was busy with river traffic, and it is possible that wrecked boats, jetty structures, or artefacts survive within the site. Isolated redeposited artefacts would be of low significance. Timber structures, such as well-preserved boat remains, would potentially be of high significance, derived from the evidential and historical value of the remains.

Post-medieval

7.4.47 The site has a high potential to contain post-medieval remains. In this period the waterfront began to advance towards the site more rapidly, particularly during the 18th and 19th centuries, when riverside wharfs, docks, piers, and both the 18th century and present Blackfriars bridges were constructed in the area of the site. On the landward side of the riverwall, buried remains associated with the construction of the

Bazalgette embankment, including infill behind the river wall and associated sewage infrastructure, would be of medium significance, by association with the listed embankment. Buried remains associated with the construction of the 1960s section of the embankment (mostly within the site) would be of low significance. In the foreshore and channel area, and potentially beneath any infill from the embankment construction on the landward side of the river wall, evidence of industrial activity may survive, including the remains of wharves, jetties, cofferdams or anchor points, of low asset significance. It is possible (moderate potential) that boat remains, similar to those discovered to the east of the Blackfriars Pier site, may survive. Such remains would be of medium or high significance, derived from their potential evidential and historical value.

Statement of significance: above-ground heritage assets

Introduction

7.4.48 In accordance with the *National Policy Statement for Waste Water* and the associated guidance, the following section provides a statement of the likely significance of built 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.

7.4.49 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 18 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

Whitefriars Conservation Area

7.4.50 The main site lies near the southern boundary of the Whitefriars Conservation Area, a heritage asset of high significance (see Vol 18 Figure 7.4.2 in separate volume of figures and illustrated in Vol 18 Plate 7.4.1). The *Character Summary* (City of London Corporation website, 2011)[6] states that the construction of the Victoria Embankment allowed the creation of the formal grid layout of streets to the north of the site in the 1880s, an unusual feature when compared to the customary evolutionary nature of street development in the capital. The buildings of the conservation area are principally late Victorian and Edwardian, with a consistency of scale. Buildings are constructed using traditional materials such as Portland and Bath limestone, brick and terracotta, which give the area a harmonious identity whilst retaining a human scale. The Victoria Embankment riverfront is described in the *Whitefriars Conservation Area Appraisal* (City of London Corporation website, 2011)[7] as one of London's most distinctive boulevards, a popular promenade for visitors to London, with wide views across and along the Thames, riverside monuments, statues, decorated benches and lamp posts.

7.4.51 The trees lining the thoroughfare also form an important component of the historic environment. These components, whether listed or not, have a shared group value, contributing in a positive way to the character of the area, which has a cohesive nature, deriving from its heritage assets. The Victoria Embankment was designed by Bazalgette to provide underground railway routes and sewers and to enable a new layout of streets, all on land reclaimed from the north bank of the Thames. As well as providing practical infrastructure, the scheme also created a prestigious grand boulevard bolstered by prominent monumental architecture, gardens, regularly planted trees and open spaces. This constructed landscape has a clear group value having remained unaltered in essence, with the parks, monuments and grand buildings being maintained or added to complement the character of the area.

7.4.52 The formal grid layout of the Whitefriars Conservation Area was created by the Corporation of London in the 1880s following the construction of the Victoria Embankment. The distinctive group of 5-6 storey buildings forming the complete frontage to Victoria Embankment and New Bridge Street creates a distinctive and dignified civic river frontage and facade to the City. The buildings along the Embankment are characterised by a varied and vigorous roof line and frontages reflecting different and contrasting architectural styles, notably the imposing curved neo-classical Unilever Building (HEA 39), the Flemish influenced City of London School (HEA 38), the Tudor Gothic Sion College (HEA 37) and 9 Carmelite Street (HEA 36), the High Victorian frontage of Carmelite House (HEA 35) and Hamilton House (HEA 34). Although altered during the construction of the road underpass in 1963, the Embankment Wall (HEA 1A), with its cast-iron sturgeon lanterns and bronze lion-head mooring rings, remains a distinctive element of the historic character of the area. All designated heritage assets within the Whitefriars Conservation Area are of high significance.

7.4.53 The river frontage forms a valuable and distinctive part of the City skyline in views across the River and towards St Pauls Cathedral, and from a significant distance along the River to east and west. The townscape effect is one of visual vitality, variety and exuberance, achieving both a pleasing harmony and a strong commercial identity, whilst retaining a human scale. Key views within the Whitefriars Conservation Area are: northwestward from Blackfriars Bridge (see View of Heritage Value 1 in Vol 18 Figure 7.4.2 in separate volume of figures and Viewpoint 2.1 detailed in Section 11); westwards along the Embankment from the north end of Blackfriars Bridge (see View of Heritage Value 2 in Vol 18 Figure 7.4.2 in separate volume of figures); eastwards along the Embankment from the moorings opposite Inner Temple Gardens towards Blackfriars Bridge (see View of Heritage Value 3 in Vol 18 Figure 7.4.2 in separate volume of figures and Viewpoint 2.12 detailed in Section 11), and towards the Embankment and the modern buildings on the opposite bank of the River Thames along John Carpenter Street, Carmelite Street and Temple Avenue. Views into the conservation area from across the River Thames are framed by Blackfriars Bridge to the east and the mature trees within Inner Temple Gardens and avenue of London plane trees along the Victoria Embankment to the west (see View of Heritage Value 4, Vol 18 Figure 7.4.2 in separate volume of figures). The Blackfriars Millennium pier structure, including the 1939 former London Fire Brigade Pumphouse and the 1960s ramp up to Blackfriars Bridge detract from the historic character of the late 19th to early 20th century Embankment and the buildings behind. Given the high significance of the area, the heritage resource may be considered an assemblage rather than a series of separate heritage assets, whereby one asset forms the setting or context of another. Given its prominence in relation to the river frontage and Embankment, the historic character and setting of the Whitefriars Conservation Area makes a strong contribution to its overall significance and that of the individual assets within its boundaries.

7.4.54 Five Grade II listed buildings within Whitefriars Conservation Area fronting Victoria Embankment are within the area of assessment for the effects of ground movement resulting from construction and tunnelling works. These are described below.

7.4.55 Dating from 1889, Hamilton House (HEA 34) is faced in Portland stone. The façade is decorated with foliate detail. Internally, some decorative plasterwork and two cantilevered staircases remain. The basement also retains some decorated timber panelling. This building is of high significance based on its historic value and the survival of significant heritage features.

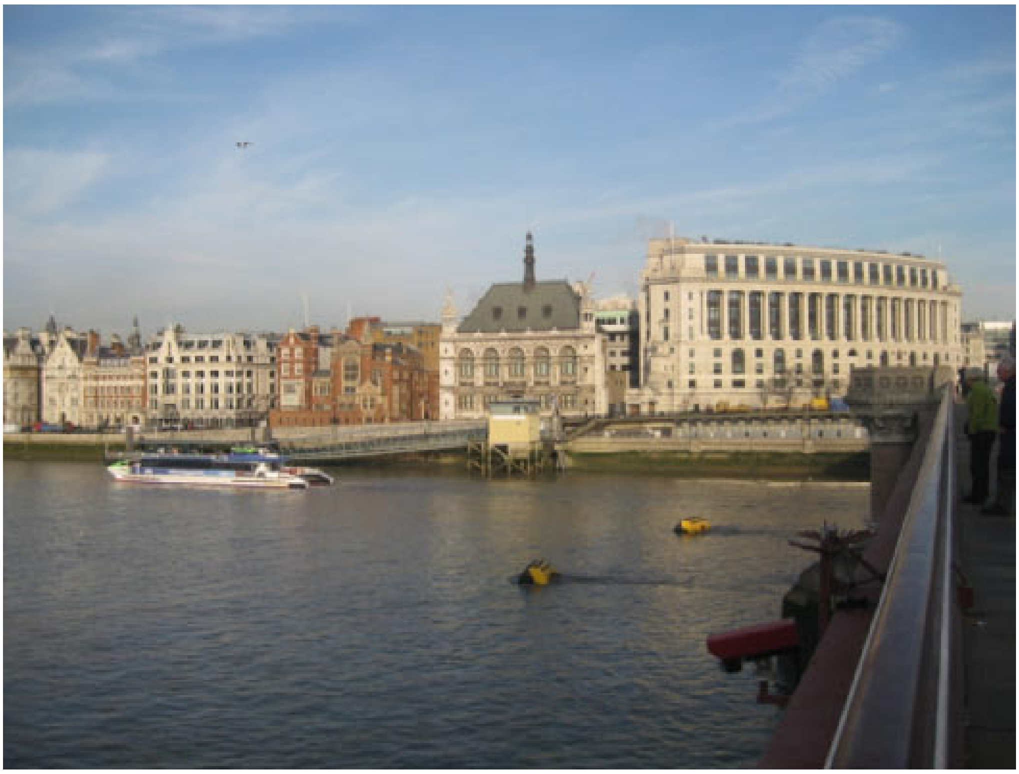
7.4.56 Telephone House (HEA 43) is a 4 storey commercial building dating from 1900, with a stone façade with decorative sculpture. Internally, the building retains some plasterwork, a cantilevered stone staircase, and tiled ‘Telephone Network’ inscribed fireplaces. Telephone House has high significance due to its retained heritage features and associative value.

7.4.57 Sion House (HEA 37) is a Tudor Gothic style brick building with stone dressings, dating from 1886, with a later brick extension to the south built around 1965. External stone details include carved grotesques and armorial devices. Internally the building retains many features including a stone cantilevered stair, plasterwork and stained glass. The double-height central former library space is galleried and has a hammerbeam ceiling. Sion House has high significance, and retains good quality historic features and finishes.

7.4.58 Dating from 1893-1894, 9 Carmelite Street (HEA 36) is a brick building with stone dressings, in a Tudor Gothic style. The decorative stonework has much in common with that of Sion House. Internally, the building now has office use but retains plaster and timber details, including a highly decorative plaster ceiling to the upper section of the former double height library (now two spaces). There is also a stone cantilevered staircase, which now has additional support in the form of iron bracing. This building has high significance.

7.4.59 Carmelite House (HEA 35) dates from the late 19th century. The building has one stair tower to the north-east, and the northern and eastern elevations of the building, are of brick with stone dressings. Behind these facades is a modern office block constructed in the late 20th century. The stair tower interior is decorated with neo-classical frescoes, and holds an Otis lift dating from the early 20th century. Although Carmelite House as a whole has high significance relating to the retained stair tower, that part of the building within the ground movement assessment area is of low significance.

Vol 18 Plate 7.4.1 Historic environment – view north towards Whitefriars Conservation Area from Blackfriars Bridge (View of Heritage Value 1)



Embankment Wall

7.4.60 The Grade II listed river wall of Bazalgette's Victoria Embankment (HEA 1A) extends into the western part of the site, and the assumed extent of the listing is shown in the As existing site features plans 1-3, see separate volume of figures - Section 1. The listed section of river wall is an asset of high significance, due to its historical, evidential and aesthetic value. The listing description includes the cast iron lamp standards, the granite retaining wall, and the piers and stairs. The section of the wall running through the main site appears to have survived the bombing of the Second World War intact and no damage is noted on the London County Council's Bomb Damage Map.

7.4.61 In the 1960s modifications were made to the bridgehead and river wall in the eastern part of the site to facilitate the construction of Blackfriars underpass, and a new section of river wall to the east of Blackfriars Bridge was added, in keeping with the earlier design. The 1960s bridgehead modifications, commemorated with a plaque on the river wall dated July 1965, enabled the construction of a subway to separate pedestrian and road traffic. This section of the wall within the eastern half of the site is thought not to be covered by the listing as it is part of the 1960s modification. The 1960s section of the wall is considered to be of medium asset significance. This is derived from its historical value in light of its association with the original, listed wall to the west.

7.4.62 The setting of the Embankment Wall (HEA 1) is defined by its relationship with the river on one side and the row of listed buildings fronting Victoria Embankment (HEA 34, 35, 36, 37, 38, 39, 40 and 43). Similarly the setting of the listed buildings is defined by their relationship with the Embankment Wall. Blackfriars Bridge also forms part of the setting of the Embankment Wall. The Blackfriars Millennium pier, the remains of the 1939 pump house, and the 1960s ramp up to Blackfriars Bridge detract from the setting of the Embankment Wall. This is shown in Views of Heritage Value 1, 2 and 4 and Vol 18 Plate 7.4.2, which illustrate views from Blackfriars Bridge towards the Whitefriars Conservation Area. Overall the setting of the Embankment Wall makes a strong contribution to its asset significance.

Vol 18 Plate 7.4.2 Historic environment – view east along the Embankment wall towards Blackfriars Bridge

Blackfriars Bridge

7.4.63 The site boundary extends beneath the northern side of Blackfriars Bridge to include the northernmost abutment and stone pier. The bridge is a Grade II Listed structure (HEA 1I) built to designs probably by Joseph Cubitt to replace an earlier bridge on the same site. It was opened in 1869 by Queen Victoria. A railway bridge, also designed by Cubitt originally lay adjacent and to the east. The road bridge was widened in 1907–1910. The carvings of marine life and water birds on its stone piers were by the sculptor John Birnie Philip. They show seawater birds on the eastern side, with fresh water birds on the west, symbolic of the site of Blackfriars as a tidal turning point. The bridge is a heritage asset of high significance, as derived from its historical and evidential value.

7.4.64 The bridge forms a distinctive element of the character and setting of the Embankment. The Blackfriars Millennium Pier structures form a significant element of the existing riverscape to the fore of the Embankment wall and detract from the historic character of the area. To the east of the bridge, there are prominent views towards the City skyline. The setting of the bridge is defined by its relationship with the Embankment wall, which has been somewhat fragmented by the 1960's underpass and road reconfiguration at the northern side of the bridge, which also detracts from the settings of the Unilever Building (HEA 38) and City of London School (HEA 38). View of Heritage Value 3 in Vol 18 Figure 7.4.2 (see separate volume of figures) represents the view along the Embankment to the junction with Blackfriars Bridge, which is also illustrated in Vol 18 Plate 7.4.2. The setting of the far side of the bridge is characterised by the presence of the abutments to the former West Blackfriars and St. Paul's Rail Bridge (HEA 41) which lie adjacent to the eastern boundary of the main site. They were constructed in 1862–1864, and whilst they are not listed, they are associated with Blackfriars Bridge and are described here due to their group value with Blackfriars Bridge. The abutments are therefore considered to be of high significance due to their evidential, historical, aesthetic and communal value. In general, given its prominence within views along and across the River Thames, setting makes a strong contribution to the significance of Blackfriars Bridge.

Former London Fire Brigade Pumphouse

7.4.65 An unlisted 20th century pump house building (HEA 1G) is situated at the eastern end of the Blackfriars Millennium Pier. This relates to the former river fire station on the site, active in the 1940s, and is a heritage asset of medium significance, derived from its historical and evidential value. Architecturally, however, this structure makes little positive contribution to the historic character of the Whitefriars Conservation Area.

Temples Conservation Area

7.4.66 A limited part of the site along the Embankment lies within the Temples Conservation Area. The part of the Temples Conservation Area adjacent to the site is characterised by the grounds, gates and railings of the Inner Temple Gardens (HEA 32, 33) which front the Embankment and the Victoria Embankment Road. There is also a continuation of the avenue of London plane trees that characterises the river front from here to the Houses of Parliament. This is illustrated in Vol 18 Plate 7.4.3. Temples Conservation Area is a heritage asset of high significance and setting makes a strong contribution to its overall significance. The site makes a limited contribution to the significance of the conservation area due its relatively small scale within the larger historic riverfront.

7.4.67 Within the boundaries of the main site, is moored the President ship (HEA 1C). Originally HMS Saxifrage built in 1917 as an Anchusa or Flower class corvette of the Royal Navy, it was a convoy protection ship against

German U boats in the First World War, disguised as a merchant vessel. The President ship is listed on the National Register of Historic Vessels (Cert No. 494) and is part of the National Historic Fleet. It has been moored at Victoria Embankment for over 80 years and has therefore been a familiar and constant presence on the river in this area. Although not statutorily protected, it is a heritage asset of high significance, derived from her evidential, communal and historical value. The presence of the President contributes positively to the historic character of the Whitefriars Conservation Area.

Pontoons

7.4.68 The existing pontoons and dolphins within the site (HEA 1L and 1M) form part of the historic river infrastructure and are considered an asset of low significance, derived from their evidential and historical value. The structures make a limited contribution to the historic character of the Whitefriars Conservation Area.

Benches

7.4.69 Five Grade II listed late 19th century cast iron benches with cast iron supports in the shape of crouching camels (HEA 72) located along the riverside pavement opposite Temple Gardens, are situated within the main site. The benches are heritage assets of high significance, as derived from their historical and evidential value. The structures make a moderate contribution to the historic character of the Whitefriars Conservation Area.

Within the assessment area

South Bank Conservation Area

7.4.70 The South Bank Conservation Area lies on the opposite bank of the Thames to the site, extending from Westminster Bridge in the south west to a point opposite Inner Temple Gardens. The conservation area is a heritage asset of high significance, and its riverside setting makes a strong contribution to its overall significance. The Blackfriars Bridge Foreshore site would be visible directly across the river from the public walkway running from the National Theatre to the west side of the Oxo Tower building, at the eastern end of the conservation area. Meanwhile the Victoria Embankment Foreshore site would be visible from another part of the conservation area, to the south west opposite County Hall. These two sites are located opposite different parts of this large conservation area, but nonetheless together they make a moderate contribution to the asset's significance due their location within the larger historic riverfront that can be viewed from the public riverside walkway.

7.4.71 There are no other heritage assets in the assessment area whose settings would be significantly adversely affected by the Thames Tideway Tunnel project. This is due to the relative distance of other heritage assets further to the southwest along the Embankment or across the River Thames and the intervening presence of structures including Blackfriars Bridge and adjacent railway bridge.

Vol 18 Plate 7.4.3 Historic environment – view west along the Embankment from Blackfriars Bridge towards Temples Conservation Area (View of Heritage Value 1)

Construction base case

7.4.72 As detailed in para. 7.3.12 whilst fluvial erosion may be 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 no other non-Thames Tideway Tunnel project developments would change the base case.

7.4.73 Other non-Thames Tideway Tunnel projects that have the potential to cause ground movement are not sufficiently close to the heritage assets affected by 1mm or more of ground movement from the Thames Tideway Tunnel works, to cause damage to them. The base case would therefore not be altered by these other projects.

7.4.74 For the reasons outlined in para.7.3.13, the base case in Site Year 2 of construction would remain as per the baseline for the assessment of effects on historic character, appearance and setting.

Operational base case

7.4.75 For the reasons outlined in para. 7.3.18 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

Buried heritage assets

7.5.1 Effects of construction works are described in the following section, with the individual impacts from each phase described. The effects on heritage assets are summarised in Section 7.10, by chronological period.

Ground disturbance on the landward side of the river wall

7.5.2 Ground disturbance on the landward side of the river wall, from temporary and permanent works including the removal of the services, subway and low level sewer, construction of the overflow weir chamber beneath the western approach ramp to Blackfriars Bridge, foundations for the welfare facilities, a permanent lift, a stair structure on the existing riverwall, and electrical and control kiosks, and tree planting, would potentially have a localised impact on buried elements of the 1960s embankment, an asset of medium significance. These works would not have an impact upon any early archaeological remains, given the depths of made ground and truncation which are likely to have resulted from the construction of Victoria Embankment and Blackfriars underpass.

7.5.3 The proposed modifications would constitute a medium magnitude of impact upon buried remains associated with the construction of the 1960s embankment, of low asset significance, and would result in a **minor adverse** effect.

7.5.4 Buried remains associated with construction of the Grade II listed Bazalgette embankment wall could be removed by ground disturbance on the landward side of the river wall. This impact on an asset of medium asset significance, would result in a **moderate adverse** effect.

Construction on the foreshore side of the river wall

7.5.5 Multi-period archaeological remains are potentially located within the foreshore alluvium and possibly cut into the underlying gravels. Within the area of the temporary cofferdam, soft material (ie alluvium) would be excavated down to the gravels adjacent to the perimeter of the temporary cofferdams and existing river wall (see assumptions in para. 7.3.24), whilst foreshore deposits would be entirely removed from within the permanent cofferdam footprint. This would constitute a high magnitude of impact on any archaeological remains within and beneath the foreshore deposits.

7.5.6 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.

7.5.7 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.

7.5.8 Jack-up barges would be used to insert the sheet pile walls of the cofferdams at the main site, and to construct the landing stage at the Blackfriars Pier site. All archaeological remains would be locally impacted within the footprint of the jack up barge supports. Excavation to a depth of 1.5m within the footprint of permanent scour protection and proposed outfall apron, would remove any surviving buried heritage assets within the foreshore alluvium to this depth. These works would have a high magnitude of impact.

7.5.9 The piles of the temporary deck and landing stage, the piles used to support the toe of the embankment wall, and piling for the reinstated access structures for HMS President, would also locally remove any archaeological remains within and around their footprints.

7.5.10 Dredging of the foreshore within the Blackfriars Pier site would be necessary within and around the area of the relocated Blackfriars Millennium Pier. This would remove any alluvium, channel silts or soft deposits along with any archaeological remains that might be present, within the dredged area.

7.5.11 These activities together would constitute a high magnitude of impact. The environmental effect would vary depending upon the significance of the assets removed:

a. There is a low potential for palaeoenvironmental remains of low or medium asset significance. Removal of such remains would reduce their significance to negligible and comprise a **minor adverse** effect.

b. There is an uncertain, possibly low potential for redeposited prehistoric artefacts of low asset significance. The removal of such remains would reduce their significance to negligible and comprise **minor adverse** effect.

c. There is a moderate to high potential for redeposited Roman artefacts of low asset significance. The removal of such remains would reduce their significance to negligible and comprise **minor adverse** effect.

d. There is a moderate to high potential for Roman ship remains, potentially of high significance. The removal of such remains would reduce their significance to negligible and comprise a **major adverse** effect. The possible surviving remains of the prow of the Blackfriars Roman boat, partially excavated in the 1960s, lie outside the cofferdam footprint, in an area that may require access from the jack up barge. As the remains are buried within alluvium in a part of the foreshore that has concrete scour protection, the legs of the jack up barge are unlikely to have an impact on this asset, and furthermore it would be protected via measures in the *CoCP* Part B (Section 12). In terms of the impact upon the setting of the Blackfriars Roman boat, it would remove much of its surviving physical context (eg channel silts and any surviving contemporary remains) but would not remove the spatial context with the Thames, the Fleet and the Roman city/waterfront. The proposals would result in a **moderate adverse** effect on the setting of the asset.

e. There is a low potential for early medieval isolated artefacts and remains associated with river usage. Such remains would be of low asset significance. Removal of such remains would reduce their significance to negligible and comprise a **minor adverse** effect respectively.

f. There is a low potential for later medieval redeposited artefacts of low asset significance. The removal of such remains would reduce their significance to negligible and comprise **minor adverse** effect.

g. There is a low potential for later medieval hulked vessels of high asset significance. The removal of such remains (if present) would reduce their significance to negligible and comprise a **major adverse** effect.

h. There is a high potential for post-medieval remains on the foreshore and embankment comprising industrial remains, wharves, jetties, cofferdams and anchor points, of low asset significance. The removal of such remains would reduce their significance to negligible and comprise a **minor adverse** effect.

i. There is high potential for buried post-medieval remains associated with the construction of the Victoria Embankment, of low asset significance (1960s section) and medium asset significance (associated with the listed section of the embankment). The localised removal would reduce their significance to negligible within the footprint of the works and would constitute a **minor** or **moderate adverse** environmental effect respectively.

j. There is a moderate potential for remains of a post-medieval hulked boat, of medium to high asset significance. Removal would reduce significance to negligible and constitute a **moderate** or **major adverse** environmental effect, depending on the asset significance.

Scour around temporary structures

7.5.12 Scour around the temporary cofferdam could have an impact upon any archaeological remains in the vicinity. The significance of any assets affected could be reduced, which would constitute a high magnitude of impact. The significance of effect on heritage assets would be as that of the cofferdams described in paras. 7.5.5–7.5.11 above.

Construction of the CSO shaft, chambers and culverts

7.5.13 Permanent works comprising the CSO shaft, valve chambers, connection to the Fleet main CSO outfall, connection culverts, and air treatment chamber would all be located within the footprint of the permanent cofferdam. The construction of these deep permanent works would entirely remove any remaining surviving archaeological remains which had not previously been removed as part of the cofferdam construction, constituting a high magnitude of impact. The significance of effect on heritage assets, if present, would be as that of the cofferdams described in paras. 7.5.5–7.5.11 above.

Above-ground heritage assets

Physical effects on above-ground heritage assets

7.5.14 The parapet of the existing 1960s (unlisted) river wall would be locally demolished to facilitate access with a section below the parapet removed to intercept the low level sewer, and a new river wall with a replacement parapet constructed along the line of the permanent foreshore structure. The 1960s river wall would also be locally removed as the cofferdams would be inserted into slots cut into the wall. The wall is an asset of medium significance. The proposed modifications would constitute a high magnitude of impact and would result in a **moderate adverse** effect.

7.5.15 The proposed development would have an impact on the listed river wall, through demolition of the parapet and from slots cut into the wall for the cofferdams. In addition, the permanent foreshore structure and new river wall would permanently change the alignment of the Bazalgette's Victoria embankment in this area. These works would constitute a medium magnitude impact on the Grade II listed Bazalgette Victoria Embankment, an asset of high significance, resulting in a **major adverse** effect.

7.5.16 The Grade II listed river wall would also be subject to ground movement effects during construction. Based on assessment of the wall as a mass gravity structure, it is predicted that there may be up to 88mm of vertical movement, resulting in slight damage risk, with potential typical crack widths of up to 5mm predicted. The magnitude of change to this asset of high significance is medium, resulting in a **moderate adverse** effect.

7.5.17 Five Grade II listed sturgeon lamp standards, which are located within the site and are of high asset significance, would be removed as part of the proposals to protect them during construction and reinstated following construction. The temporary loss of these structures within their historic context would comprise a high magnitude of impact, constituting a **moderate adverse** effect, prior to reinstatement.

7.5.18 Two Grade II listed benches located within the site, of high asset significance, would be removed as part of the proposals to protect them during construction and reinstated following construction. The temporary loss of these structures within their historic context would comprise a high magnitude of impact, constituting a **moderate adverse** effect, prior to reinstatement at the same locations.

7.5.19 The unlisted, 20th century former London Fire Brigade Pumphouse, of medium asset significance, would be demolished as part of the proposals. This comprises a high magnitude of impact, constituting a **major adverse** effect.

7.5.20 Removal of the pontoons, platforms and dolphins and river infrastructure associated with access for shipping, of low significance, would comprise a **minor adverse** effect.

7.5.21 The President ship, of high asset significance, would be moved approximately 100m upstream of its present location and there would be no physical impact upon the ship resulting from the proposals, constituting a **negligible** effect.

7.5.22 Although outside of the site boundary, five listed buildings (Carmelite House, Telephone House, Sion House, 9 Carmelite Street and Hamilton House) would be subject to at least 1mm of ground movement resulting from the proposed works. In all cases the listed buildings are located to the very edge of the settlement zone, with settlement of no more than 3mm beneath any building predicted. Only the southern facades of buildings would experience this settlement. The damage assessment predicts that the resulting damage risk is negligible, with a possibility of surface cracking typically up to 0.1mm to these façades. This would result in a negligible magnitude of change to these buildings of high significance, constituting a **minor adverse** effect.

7.5.23 Grade II listed Blackfriars Bridge would be subject to ground movement effects, concentrated to its northern end where the bridge is within the site. The bridge is expected to experience total movements of up to 6.1mm, resulting in a risk of negligible damage, with a risk of cracks typically up to 0.1mm in width. This would represent a negligible magnitude of change to an asset of high significance, with a **minor adverse** effect.

Effects on the historic character and setting of above-ground heritage assets

7.5.24 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.

Whitefriars Conservation Area

7.5.25 The construction works would form prominent features within key views from Blackfriars Bridge along the Embankment (Viewpoint 2.1 detailed in Section 11 Townscape and visual) and towards the Whitefriars Conservation Area from the opposite bank of the River Thames. This would affect the setting of the wider Victoria Embankment, including the listed buildings along the frontage, Blackfriars Bridge and the Inner Temple Gardens. The installation of hoardings along the Embankment would obstruct views to the wall along the riverside walkway at this point. The temporary removal of three sturgeon lanterns would also affect the character of the structure and setting of the Embankment. Given the high significance of the asset, combined with the medium magnitude of change, the construction works would have a **moderate adverse** effect on the setting of the Whitefriars Conservation Area and its associated heritage assets.

7.5.26 The separate townscape and visual assessment (Section 11) concludes that the works would have a major adverse effect upon the conservation area. The difference between the two assessments derives from their different methodologies: with the historic environment assessment considering the effect upon the heritage value of the entire conservation area, of which only a part is affected by the proposals while some key areas are completely unaffected; whereas the townscape assessment considers the effect upon the immediate riverside setting of the townscape of the conservation area and also considers non-heritage factors.

The Embankment Wall

7.5.27 In addition to the direct effects of construction, the construction works would detract from the setting of that part of the Embankment Wall (HEA 1A) which has intervisibility with the site, obscuring views to this part of the Embankment from Blackfriars Bridge and across the River Thames. Given the high significance of the asset, combined with the high magnitude of change, the construction works would have a **moderate adverse** effect on the setting of the Embankment Wall.

7.5.28 The separate townscape and visual assessment (Section 11) concludes that the works would have a minor adverse effect upon views from the Thames Path (i.e. along the Embankment Wall) towards the site (viewpoints 2.9, 2.10 and 2.11). The difference between the two assessments derives from their different methodologies: one considers the effect upon the heritage value of the Embankment Wall, whereas the other considers the effect upon views experienced by recreational receptors within the wider townscape, which includes non-heritage factors.

Blackfriars Bridge

7.5.29 The construction works would detract from views eastwards along the Embankment towards Blackfriars Bridge. However, this would only affect the northern part of the bridge, leaving the southern part open to views from along the river frontage. This would therefore constitute a medium magnitude of change, resulting in a **moderate adverse** effect.

7.5.30 The separate townscape and visual assessment (Section 11) concludes that the works would have a major adverse effect upon views from the listed bridge (Viewpoint 2.1). The difference between the two assessments derives from their different methodologies: the historic environment assessment considers the effect upon the heritage value of the bridge, whereas the other considers the effects upon views experienced by recreational receptors within the wider townscape, which includes non-heritage factors.

Temples Conservation Area

7.5.31 The proposed relocation of the President (HEA 1C) upstream from its current position would detract from existing views to the Temples Conservation Area and Inner Temple Garden (HEA 16) from the opposite bank of the River Thames. The construction works would detract from the riverside part of this conservation area, and from riverside views to and from the asset. This would have a medium magnitude of change, resulting in a **moderate adverse** effect.

7.5.32 The separate townscape and visual assessment (Section 11) concludes that the works would have a major adverse effect upon the conservation area. The difference between the two assessments derives from their different methodologies: the historic environment assessment considers the effect upon the heritage value of the entire conservation area, of which only a part, some distance from the key features of the Temple buildings, is affected by the proposals, whereas the townscape assessment considers the effect upon the immediate riverside setting of the townscape of the conservation area, which includes non-heritage factors.

South Bank Conservation Area

7.5.33 The construction works at the Blackfriars Bridge Foreshore and Victoria Embankment Foreshore sites would combine to affect the setting of this conservation area, through the erection of site hoardings, office and welfare accommodation, temporary and permanent cofferdams within the river, and the presence of cranes and other plant. As the riverfront of the South Bank Conservation Area offers wide public views from the riverside walkway, there would be a medium magnitude of impact upon this highly significant asset (although other aspects of the conservation area would be less affected), leading to a **moderate adverse** effect.

7.5.34 The separate townscape and visual assessment (Section 11) concludes that the works would have a major adverse effect upon the conservation area. The difference between the two assessments derives from their different methodologies with the historic environment assessment recognising that much of the historic setting of the area would be largely unaffected, whereas the townscape assessment is concerned with the riverside setting in the immediate vicinity and includes other non-heritage factors.

Sensitivity test for programme delay

7.5.35 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 because all relevant developments, as identified in the development schedule (Vol 18 Appendix N), beyond the site would be completed by the commencement of the Thames Tideway Tunnel development. Therefore no changes in the base case, against which construction effects are assessed, is anticipated.

7.6 Operational effects assessment

Effects on the historic character and setting of above-ground heritage assets

Whitefriars Conservation Area

7.6.1 The permanent foreshore structure would alter the historic character of the Whitefriars Conservation Area by introducing a new element to the southern boundary of the Embankment. This would both alter the line and regularity of the Embankment wall and the relationship between of the Embankment wall and Blackfriars Bridge. The permanent foreshore structure would be prominent in views towards the Whitefriars Conservation Area, and listed buildings along the Embankment from

Blackfriars Bridge and the opposite bank of the River Thames, as well as eastwards from the Embankment towards Blackfriars Bridge. Overall, however, the existing arrangement and visual effect of the river with the Embankment Wall and buildings rising beyond would not be significantly altered, not least as the proposed development would be largely below the line of the Embankment wall and down the ramp from Blackfriars Bridge. The relocation of the President to her existing location following construction would have no effect on the setting of heritage assets or character of the Whitefriars Conservation Area.

7.6.2 The proposed development would also affect the character of that part of the Whitefriars Conservation Area adjacent to the site by altering the setting of the buildings along Victoria Embankment (HEA 34, 35, 36, 37, 38, 39). However, this would be limited to views to the buildings from Blackfriars Bridge and across from the opposite bank of the River Thames, in which the foreshore structure would be prominent. As the edge of the foreshore structure would be below or at the same height as the Embankment Wall, views to and from the buildings along Victoria Embankment and along the adjacent side streets towards the River Thames would not be affected. Furthermore, the ventilation columns would be largely concealed from view beneath the Embankment wall where it rises to meet Blackfriars Bridge and by the presence of planting. The reinstatement of trees along the Embankment would also enhance the setting of the buildings. The removal of the former London Fire Brigade Pumphouse, Blackfriars Millennium Pier structures and 1960s elements that detract from the historic character of the conservation area and replacement with a new low level public space would enhance the setting and provide new views of the riverscape. This would better reveal the significance of the relationship between Blackfriars Bridge and the adjacent former railway bridge piers, and the scale and detailing of the Embankment Wall.

7.6.3 Overall, given the high significance of the Whitefriars Conservation Area and its prominence on the river frontage, the magnitude of change presented by the proposed development would be medium, resulting in a **moderate adverse** effect.

7.6.4 The separate townscape and visual assessment (Section 11) concludes that the operational development would have a minor beneficial effect upon the conservation area. The difference between the two assessments derives from their different methodologies: the historic environment assessment considers the effect upon the heritage value of the conservation area; whereas the townscape assessment considers the effect upon the townscape of the conservation area, which includes non-heritage factors.

The Embankment Wall

7.6.5 The foreshore structure would considerably alter the historic character and setting of the Embankment Wall, in particular when viewed from across the River Thames and from Blackfriars Bridge. Views east along the Embankment would be less affected due to the presence of mature vegetation and the position of the foreshore structure in relation to the wall. The effect would be reduced in part by the retention of the upper part of the existing wall, mooring rings and lanterns, and that it would afford views of the nature and detailing of the Embankment Wall, hence better revealing its significance. Overall, given the high significance of the Embankment Wall, the magnitude of change presented by the proposed development would be medium, resulting in a **moderate adverse** effect.

7.6.6 The separate townscape and visual assessment (Section 11) concludes that the operational site would have a minor adverse effect upon the Viewpoint 2.11: View east from the Thames Path opposite Milford Lane (i.e. along the Embankment Wall), with negligible effects predicted on viewpoints further west (viewpoints 2.9 and 2.10). The difference between the two assessments derives from their different methodologies: the historic environment assessment considers the effect upon the heritage value of the Embankment Wall, whereas the townscape assessment considers the effect upon views experienced by recreational receptors within the wider townscape, which includes non-heritage factors.

Blackfriars Bridge

7.6.7 The permanent foreshore structure would adversely alter the current arrangement between the Embankment wall and Blackfriars Bridge, projecting into views towards the site from the Embankment and the opposite bank of the River Thames. However, the effect would be limited to the northern side of the bridge, allowing the majority of the structure to retain its current form and setting. Conversely, the removal of the former London Fire Brigade Pumphouse, Blackfriars Millennium Pier structures and 1960s elements that detract from the setting of Blackfriars Bridge and their replacement with a structure of unified design would have a beneficial effect. The introduction of the low level foreshore structure would provide new views of the riverscape. This would better reveal the significance of the relationship between Blackfriars Bridge and the adjacent bridge piers, and their relationship with the Embankment Wall.

7.6.8 Overall the high significance of the asset, combined with a medium magnitude of change, would have a **moderate adverse** effect.

7.6.9 The separate townscape and visual assessment (Section 11) concludes that the works would have a minor adverse effect upon views from the listed bridge (Viewpoint 2.1). The difference between the two assessments derives from their different methodologies: the historic environment assessment considers the effect upon the heritage value of the bridge, whereas the other considers the effects upon views experienced by recreational receptors within the wider townscape, which includes non-heritage factors.

Temples Conservation Area

7.6.10 The setting of the Temples Conservation Area and Inner Temple Gardens, together with its associated gates, railings and gate piers (HEA 16, 32, 33), would not be affected by the operational development due to the low position of the foreshore structure in relation to the Embankment wall and the intervening presence of mature trees along the Embankment. The magnitude of change presented by the proposed development would be negligible on Temple Conservation and its component heritage assets (of high asset significance) resulting in a **minor adverse** effect.

7.6.11 The separate townscape and visual assessment (Section 11) similarly concludes that the works would have a minor adverse effect upon the conservation area.

South Bank Conservation Area

7.6.12 The operational structures at the Blackfriars Bridge Foreshore and Victoria Embankment Foreshore sites would combine to affect the setting of this conservation area, by changing the riverscape in two places visible from the riverside walkway. The sites would generally not rise above the parapet of the existing river wall in views from the conservation area, leading to a low magnitude of impact upon this highly significant asset, giving a **minor adverse** effect. Most of this effect would come from the Blackfriars Bridge Foreshore site, due to its greater prominence.

7.6.13 The separate townscape and visual assessment (Section 11) similarly concludes that the works would have a minor adverse effect upon the conservation area.

Sensitivity test for programme delays

7.6.14 For the assessment of historic environment effects during the operational phase, a delay to the Thames Tideway Tunnel project of approximately one year would not be likely to materially change the assessment findings because all relevant developments, as identified in the development schedule (Vol 18 Appendix N), beyond the site would be completed by the commencement of the Thames Tideway Tunnel development. Therefore no changes in the base case, against which operational effects are assessed, is anticipated.

7.7 Cumulative effects assessment

7.7.1 As all of the schemes set out in the site development schedule (Vol 18 Appendix N) would be completed and operational by the start of the Thames Tideway Tunnel project construction phase, there would be no cumulative effects on below or above-ground heritage assets.

Sensitivity test for programme delays

7.7.2 In the event that the programme for the Thames Tideway Tunnel project is delayed by approximately one year, all the schemes set out in the site development schedule would remain completed and operational by the start of the Thames Tideway Tunnel project. Therefore, there would remain no cumulative effects during either the construction or operational phases.

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.

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 It should be noted that as detailed in para. 7.2.22, any remains of the Roman boat would be protected through measures in the CoCP Part B, whereby contractors would use suitable river plant and operating procedures for in-river works to minimise the risk of impact on the boat.

7.8.4 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.

7.8.5 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, foundations for offices, welfare and lift, and planting on the landward side of the existing river wall.

b. Targeted archaeological excavation, within the footprints of the proposed temporary cofferdam, in order to mitigate the effects on the river side of the existing river wall. The precise approach to survey and excavation would depend on the detailed construction methodology and the results of field evaluation.

c. For works taking place below low water on the outside of the cofferdams (i.e. dredging), conventional archaeological investigation would not be feasible. In such an eventuality other techniques would be employed, such as monitoring and scanning the dredged material.

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 cofferdam 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 Removal and alteration of the fabric of the Bazalgette Grade II listed embankment wall (an asset of high significance), and the demolition of the unlisted 20th century pump house, would require a programme of standing structure survey and recording prior to and during alteration/demolition, to English Heritage Level 3 standard (English Heritage, 2006)[8]. This would comprise an analytical record with additional archival and documentary research, and a written, photographic and drawn record, and would achieve preservation by record (through advancing understanding of asset significance).

7.8.9 The moderate adverse effect arising from the removal and alteration of the fabric of the 1960s river wall, an asset of medium significance, would be mitigated through survey and recording to English Heritage Level 2 standard (English Heritage, 2006)[9] . This would comprise a descriptive record, with additional archival and documentary research, and a brief written record and photographs, to achieve preservation by record.

7.8.10 The listed river wall would require mitigation to address the effects of ground movement, which are assessed as having a moderate adverse effect. Mitigation for ground movement would include some or all of the following as appropriate: monitoring of the structure prior to and during construction, to ensure that damage levels are as predicted and that the risk of excessive damage is minimised; installation of compensation grouting to counteract ground movement; construction control and volume loss control methods to reduce ground movement and further site investigation to determine the existing factor of safety. The precise methods of mitigation would be determined following further assessment and in accordance with *CoCP, Part A* (Section 12), and detailed proposals would be the subject of a requirement of consent. For the purposes of this assessment it is assumed that monitoring, and construction and volume loss control would be undertaken. Damage to the significance of wall finishes would be repaired as part of the construction process, using appropriate conservation methods in accordance with *CoCP*, Part A (Section 12).

7.8.11 Blackfriars Bridge would be monitored to measure ground movement during construction. . Any damage to significance would be repaired using appropriate conservation methods following the conclusion of the works.

7.8.12 No mitigation is likely to be required to the listed buildings along the embankment, as the potential for damage resulting from ground movement is not predicted to cause significant damage to the buildings. Nevertheless these structures would be monitored and any damage to significance would be repaired using appropriate conservation methods following the conclusion of the works.

7.8.13 The temporary removal of five Grade II listed sturgeon lamp standards on the river wall and two Grade II listed benches (heritage assets of high significance), and the removal of pontoons and dolphins and river infrastructure associated with access to shipping, would require recording prior to removal, to English Heritage Level 1 standard (English Heritage, 2006)[10]. This would comprise a brief written and photographic record, to achieve preservation by record. All measures embedded in the proposed development and *CoCP* of relevance to the assessment of effects on the historic character and setting of above-ground heritage assets during construction are summarised in Section 7.2. No further mitigation during construction is possible due to the highly visible nature of the construction activities.

7.8.14 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 in the operational phase are summarised in Section 7.2. No further mitigation is possible due to the highly visible nature of the permanent foreshore structure.

7.9 Residual effects assessment

Construction effects

7.9.1 With the mitigation described above in place, the residual construction effects on buried heritage assets would be **negligible**. All residual effects are presented in Section 7.10.

7.9.2 The proposed permanent change to a stretch of Grade II listed river wall would be partly mitigated through recording. The residual effect would be **moderate adverse**.

7.9.3 Ground movement mitigation to the Grade II listed river wall, at a minimum including monitoring and construction and volume loss controls, would result in a **negligible** effect. Ground movement effects on all other listed structures from ground movement would also be **negligible**.

7.9.4 The effects of demolition of a mid 20th century former London Fire Brigade Pumphouse, and removal of pontoons and dolphins would be entirely mitigated. The residual effect would be **negligible**.

7.9.5 The temporary removal of Grade II listed benches and lamp standards would be entirely mitigated by recording and the residual effects would be **negligible**.

7.9.6 As no mitigation measures are proposed for 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 7.6. All residual effects are presented in Section 7.10.

Operational effects

Above-ground heritage assets

7.9.7 As no mitigation measures are proposed 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

Vol 18 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				
Low potential for palaeoenvironmental remains (Low or medium asset significance)	Assets affected by construction on the foreshore side of the river wall. Assets removed by scour around temporary structures. Assets removed by construction of the CSO shaft, chambers and culverts. Asset significance reduced to negligible.	Minor adverse	Targeted archaeological investigation and recording, including environmental sampling, within the area of the temporary cofferdam and foreshore ground works. Scanning and monitoring dredged material within the area of proposed dredging at Blackfriars Pier site. Monitoring of scour and provision of scour protection if required and agreed with statutory consultees.	Negligible
Uncertain, possibly low potential for prehistoric redeposited artefacts (Low asset significance)	Assets affected by construction on the foreshore side of the river wall. Assets removed by scour around temporary structures. Assets removed by construction of the CSO shaft, chambers and culverts. Asset significance reduced to negligible.	Minor adverse		Negligible
Moderate to high potential for Roman redeposited artefacts (Low asset significance)	Assets affected by construction on the foreshore side of the river wall. Assets removed by scour around temporary structures. Assets removed by construction of the CSO shaft, chambers and culverts. Asset significance reduced to negligible.	Minor adverse		Negligible

Receptor (Heritage asset)	Effect	Significance of effect	Mitigation	Significance of residual effect
Moderate to high potential for Roman ship remains (high asset significance) (separate to known Roman boat – see row below)	Assets affected by construction on the foreshore side of the river wall. Assets removed by scour around temporary structures. Assets removed by construction of the CSO shaft, chambers and culverts. Asset significance reduced to negligible.	Major adverse		Negligible
Roman boat (high significance) and its setting (Medium significance)	Remains of the known in situ Blackfriars Roman boat would not be physically affected, although there would be an impact upon its setting.	No effect on known remains of Roman boat Moderate adverse effect on setting of boat		
Low potential for early medieval remains, including isolated artefacts (Low asset significance)	Assets affected by construction on the foreshore side of the river wall. Assets removed by scour around temporary structures. Assets removed by construction of the CSO shaft, chambers and culverts. Asset significance reduced to negligible.	Minor adverse		Negligible
Low potential for later medieval redeposited artefacts (Low asset significance)	Assets affected by construction on the foreshore side of the river wall. Assets removed by scour around temporary structures.	Minor adverse		Negligible

Receptor (Heritage asset)	Effect	Significance of effect	Mitigation	Significance of residual effect
	Assets removed by construction of the CSO shaft, chambers and culverts. Asset significance reduced to negligible.			
Low potential for later medieval hulked vessels (High asset significance)	Assets affected by construction on the foreshore side of the river wall. Assets removed by scour around temporary structures. Assets removed by construction of the CSO shaft, chambers and culverts. Asset significance reduced to negligible.	Major adverse		Negligible
High potential for post-medieval industrial remains, wharves, jetties, cofferdams, anchor points (Low asset significance)	Assets affected by construction on the foreshore side of the river wall. Assets removed by scour around temporary structures. Assets removed by construction of the CSO shaft, chambers and culverts. Asset significance reduced to negligible.	Minor adverse		Negligible
High potential for buried remains associated with the 1960s embankment construction (Low asset significance)	Assets removed by ground disturbance on the landward side of the river wall. Asset significance reduced.	Minor adverse	Archaeological watching brief to form preservation by record.	Negligible
High potential for buried remains associated with the	Assets removed by ground disturbance on the landward side of the river wall.	Moderate adverse	Archaeological watching brief to form preservation by	Negligible

Receptor (Heritage asset)	Effect	Significance of effect	Mitigation	Significance of residual effect
Bazalgette embankment construction (Medium asset significance)	Asset significance reduced.		record.	
High potential for post-medieval vessels (Medium to high asset significance)	Assets affected by construction on the foreshore side of the river wall. Assets removed by scour around temporary structures. Assets removed by construction of the CSO shaft, chambers and culverts. Asset significance reduced to negligible.	Moderate or Major adverse (depending on asset significance)	Targeted archaeological investigation and recording, including environmental sampling, within the area of the temporary cofferdam and foreshore ground works. Scanning and monitoring dredged material within the area of proposed dredging at Blackfriars Pier site. Monitoring of scour and provision of scour protection if required and agreed with statutory consultees.	Negligible
Above-ground heritage assets				
Bazalgette's Victoria Embankment.	Local demolition and reinstatement of the parapet wall along the line of the foreshore	Major adverse	Standing structure recording and	Moderate adverse

Receptor (Heritage asset)	Effect	Significance of effect	Mitigation	Significance of residual effect
(High asset significance)	structure. Removal of three lamp standards, which would be reinstated at the end of construction. Asset significance reduced.		photographic survey to English Heritage survey level 3, to form preservation by record. Protection of asset and reinstatement where practical.	
	Ground movement effects resulting from tunnelling and construction, with the potential to cause cracking on the river wall, with cracks up to 5mm wide	Moderate adverse	As a minimum, mitigation is proposed to include construction controls to reduce the level of movement – to be determined following full mitigation design. The wall would be monitored throughout construction. Any damage to significance would be repaired using appropriate conservation methods following the conclusion of the works.	Negligible
Unlisted 1960s modifications to river	Localised demolition and reinstatement of the embankment wall where the overflow weir	Moderate	Standing structure recording and	Negligible

Receptor (Heritage asset)	Effect	Significance of effect	Mitigation	Significance of residual effect
wall (Medium asset significance)	chamber is located. Asset significance reduced.	adverse	photographic survey to English Heritage survey level 2, to form preservation by record.	
Five listed sturgeon lamp standards (High asset significance)	Temporary removal of lamp standards which would be reinstated at the end of construction. Asset significance reduced.	Moderate adverse	Recording and photographic survey to English Heritage survey level 1, to form preservation by record.	Negligible
Two listed benches (High asset significance)	Temporary removal of benches which would be reinstated at the end of construction. Asset significance reduced.	Moderate adverse	Recording and photographic survey to English Heritage survey level 1, to form preservation by record.	Negligible
Unlisted 20th century former London Fire Brigade Pumphouse (Medium asset significance)	Demolition of the pump house. Asset significance reduced to negligible.	Major adverse	Standing structure recording and photographic survey to English Heritage survey level 3, to form preservation by record.	Negligible
Pontoons and dolphins and river infrastructure (Low asset	Demolition of pontoons, dolphins and river infrastructure. Asset significance reduced to negligible.	Minor adverse	Recording and photographic survey to English Heritage survey level 1, to form	Negligible

Receptor (Heritage asset)	Effect	Significance of effect	Mitigation	Significance of residual effect
significance)			preservation by record.	
HMS President (High asset significance)	The ship would be moved to an alternative location.	Negligible	None	Negligible
Blackfriars Bridge (High asset significance)	Negligible physical effect upon the listed bridge from the replacement stairs to the east and west via the existing break in the parapet	Negligible	None	Negligible
	Ground movement from construction and tunnelling is likely to result in a negligible damage risk, typically with cracks up to 0.1mm	Minor adverse	The structure would be monitored. Any damage to significance would be repaired using appropriate conservation methods following the conclusion of the works	Negligible
	The construction works would detract from the setting of Blackfriars Bridge	Moderate adverse	No mitigation possible further to that embodied within the proposed design and the *CoCP* and environmental design principles.	Moderate adverse

Receptor (Heritage asset)	Effect	Significance of effect	Mitigation	Significance of residual effect
Hamilton House (High asset significance)	Ground movement resulting from construction and tunnelling is likely to result in a negligible damage risk, typically with cracks up to 0.1mm	Minor adverse	The structure would be monitored. Any damage to significance would be repaired using appropriate conservation methods following the conclusion of the works.	Negligible
Telephone House (High asset significance)	Ground movement resulting from construction and tunnelling is likely to result in a negligible damage risk, typically with cracks up to 0.1mm	Minor adverse	The structure would be monitored. Any damage to significance would be repaired using appropriate conservation methods following the conclusion of the works.	Negligible
Sion House (High asset significance)	Ground movement resulting from construction and tunnelling is likely to result in a negligible damage risk, typically with cracks up to 0.1mm	Minor adverse	The structure would be monitored. Any damage to significance would be repaired using appropriate conservation methods following the	Negligible

Receptor (Heritage asset)	**Effect**	**Significance of effect**	**Mitigation**	**Significance of residual effect**
			conclusion of the works.	
9 Carmelite Street (High asset significance)	Ground movement resulting from construction and tunnelling is likely to result in a negligible damage risk, typically with cracks up to 0.1mm	Minor adverse	The structure would be monitored. Any damage to significance would be repaired using appropriate conservation methods following the conclusion of the works.	Negligible
Carmelite House (High asset significance)	Ground movement resulting from construction and tunnelling is likely to result in a negligible damage risk, typically with cracks up to 0.1mm	Minor adverse	The structure would be monitored. Any damage to significance would be repaired using appropriate conservation methods following the conclusion of the works.	Negligible
Whitefriars Conservation Area (High asset significance)	The construction works would significantly detract from the historic character of the river frontage within the southern boundary of the conservation area	Moderate adverse	No mitigation possible further to that embodied within the proposed design and the *CoCP* and environmental design	Moderate adverse

Receptor (Heritage asset)	Effect	Significance of effect	Mitigation	Significance of residual effect
			principles.	
The Embankment Wall, including associated lamp standards and benches (High asset significance)	The construction works would detract from the historic character of the river frontage	Moderate adverse	No mitigation possible further to that embodied within the proposed design and the *CoCP* and environmental design principles.	Moderate adverse
Temples Conservation Area (High asset significance)	The construction works would detract from the riverside part of the Temples Conservation Area, producing a medium magnitude of change.	Moderate adverse	No mitigation possible further to that embodied within the proposed design and the *CoCP* and environmental design principles.	Moderate adverse
South Bank Conservation Area (High asset significance)	The construction works at Blackfriars Bridge Foreshore and Victoria Embankment Foreshore sites would combine to cause a medium magnitude of change to the setting of the South Bank Conservation Area.	Moderate adverse	No mitigation possible further to that embodied within the proposed design and the *CoCP* and environmental design principles.	Moderate adverse

Vol 18 Table 7.10.2 Historic environment – summary of operational assessment

Asset (receptor)	Effect	Significance of effect	Mitigation	Residual effect
Whitefriars Conservation Area (High asset significance)	The operational proposed development would introduce a medium magnitude of change in the historic character and appearance of this part of the Whitefriars Conservation Area, minimised by the nature of the design of the foreshore structure and associated landscaping	Moderate adverse	No mitigation possible further to that embodied within the proposed design and environmental design principles.	Moderate adverse
Embankment Wall (High asset significance)	The operational proposed development would introduce a medium magnitude of change in the setting of the Embankment Wall, minimised by the nature of the design of the foreshore structure and associated landscaping	Moderate adverse	No mitigation possible further to that embodied within the proposed design and environmental design principles.	Moderate adverse
Blackfriars Bridge (High asset significance)	The operational proposed development would introduce a low magnitude of change in the setting of the bridge	Moderate adverse	No mitigation possible further to that embodied within the proposed design and environmental design principles.	Moderate adverse
Temples Conservation Area (High asset significance)	The operational structure would have a negligible effect on the setting of Temples Conservation Area	Minor adverse	No mitigation required further to that embodied within the proposed design and environmental design principles.	Negligible
South Bank	The operational structures at	Minor adverse	No mitigation required further	Negligible

Asset (receptor)	Effect	Significance of effect	Mitigation	Residual effect
Conservation Area (High asset significance)	Blackfriars Bridge Foreshore and Victoria Embankment Foreshore would combine to cause a low magnitude of change to the setting of the South Bank Conservation Area.		to that embodied within the proposed design and the *CoCP* and environmental design principles.	

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[1] *National Historic Ships UK website*. Available at: http://www.nationalhistoricships.org.uk. Accessed May 2011.

[2] Department of Environment, Food and Rural Affairs*. National Policy Statement for Waste Water* (2012)

[3] Communities and Local Government*. National Planning Policy Framework* (March 2012)

[4] Department of Communities and Local Government, English Heritage & Department for Culture, Media and Sport*. PPS5 Planning for the Historic Environment: Historic Environment Planning Practice Guide* (March 2010)

[5] Cross-Rudkin, P. *Centres for Large Span Masonry Arch Bridges in Britain to 1833*. Second International Congress on Construction History. Department of Architecture, University of Cambridge (2006), 890.

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.18**

Volume 18 Blackfriars Bridge Foreshore site assessment

Section 8: Land quality

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

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Thames Tideway Tunnel

Environmental Statement

Volume 18: Blackfriars Bridge 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 Blackfriars Bridge Foreshore site (both the main site and the Blackfriars Pier 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 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 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).

8.1.6 Plans of the proposed development as well as figures included in the assessment for this site are contained in a separate volume (Volume 18 Blackfriars Bridge 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 a temporary cofferdam and partial demolition of existing river wall and construction of a new section of river wall including the connection to and alteration of existing wall and scour protection works

b. demolition of existing Blackfriars Millenium Pier and associated ramps, steps and offices, in addition to the demolition of the westbound ramp,

c. construction of pits, chambers, ducts and pipes for cables, pipes, utility connections and diversions and drainage

d. combined sewer overflow (CSO) drop shaft, the invert of which would be located at a depth of approximately 53m below ground level (bgl), within the Thanet Sand Formation

e. CSO Interception chamber, CSO overflow structures and hydraulic structures including culverts

f. construction of electrical and control kiosks

g. construction of 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 18 Blackfriars Bridge 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 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, City of London 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 18 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 Blackfriars Bridge Foreshore site (see Vol 18 Appendix F.3).

c. drilling of boreholes and assessment of soil and groundwater quality.

8.2.9 In view of the lack of contaminative history within the site area and the low risk current land use (River Thames foreshore for main works and Blackfriars Pier for other works); 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 however considered that the information used to produce this ES would be reformatted into 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, as standard, 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, or previously unidentified contamination), 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, additional 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).

8.2.13 Although it is unlikely to be specifically required due to poor soil quality, site control measures would as a standard 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*).

8.2.14 Monitoring of excavations would be undertaken by a UXO specialist due to the high risk of encountering UXO within the foreshore environment.

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 City of London Corporation was specifically consulted with respect to any land quality data they hold at the site and surrounding area. A review of this data is presented in Vol 18 Appendix F.1 and Vol 18 Appendix F.2.

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 18 Appendix N. The baseline is expected to change between the base case year and Site Year 1 of construction (2017). There are 3 developments within the 250m buffer area (as shown in Vol 18 Table 8.3.1) which are likely to be complete and operational before the commencement of the construction phase and as a result forms part of the construction base case.

8.3.8 There are no proposed developments expected to commence during Site Year 1 of construction and as a result there would be no cumulative effects on land quality.

Vol 18 Table 8.3.1 Land quality – construction base case and cumulative assessment development

Development	Distance from site	Construction base case	Cumulative impact assessment
Puddle Dock, Mermaid Theatre (erection of hotel)	103m north	✓	✗

Symbols ✓ applies ✗ does not apply

8.3.9 Section 8.5 details the likely significant effects arising from the construction at the Blackfriars Bridge Foreshore site and Blackfriars Pier 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 Blackfriars Bridge Foreshore site.

Limitations

8.3.17 There is limited site-specific ground investigation data within some parts of the LLAU. 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 18 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 18 Appendix F, this section should also be read in conjunction with Vol 18 Figure F.1.1, Vol 18 Figure F.1.2 and Vol 18 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 1.5m bgl. This is underlain (in turn by) River Terrace Deposits, London Clay Formation, Lambeth Group and Thanet Sand Formation (see Vol 18 Appendix F.1, Vol 18 Table F.3 for the full geological succession).

8.4.5 Within the river bank construction area a cover of Made Ground may also be expected.

Contamination

8.4.6 The area within the LLAU has not been subject to major contaminative history. No notable contamination sources were identified with the site boundaries or in the immediate vicinity of the site.

8.4.7 The site comprises the current River Thames foreshore. The Thames foreshore sediments within 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.

8.4.8 The levels of various potential contaminants in the sediments are relatively low in terms of risk to human health (when compared to widely used screening values (Defra/ EA, 2012[4] and Land Quality Management/Chartered Institute of Environmental Health, 2012[5]) 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) (see the *Sediment sampling report* which forms Vol 2 Appendix F.2). The majority of the excavated materials at the site from the CSO drop shaft would therefore be essentially uncontaminated.

8.4.9 Overall on the basis of the current information it is considered that the site has a very low risk of containing contaminated soils or groundwater.

UXO

8.4.10 A desk based assessment for UXO threat was undertaken for the proposed development site. The report reviews information sources such as the Ministry of Defence (MoD), Public Records Office and the Port of London Authority (PLA). The report is presented in Appendix F.3.

8.4.11 The report identified that there were bombing targets close by and bomb strikes were recorded in part of the proposed site area.

8.4.12 The site was therefore given a high risk rating.

Summary of receptors

8.4.13 The receptors identified at this site from the baseline survey (see Vol 18 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 (high sensitivity), recreational users such as Inner Temple Garden users (medium sensitivity) and workers in the adjacent commercial, administrative/retail properties and Thames Path users (low sensitivity)

c. built environment: listed structures such as Bazalgette's embankment and Blackfriars Bridge and other listed structures (high sensitivity) and commercial/administrative, retail and residential properties and river wall (low sensitivity).

Construction base case

8.4.14 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 but also applies to other areas due to the lack of contaminative land use history and low potential for harmful levels of contamination to be present within the LLAU.

Development of conceptual model

Interactions between source-pathway-receptor

8.5.2 The following section outlines how the contamination sources summarised in paras.8.4.6 to 8.4.9 may interact with the receptors identified during the construction phase (see para. 8.4.13) following the application of the embedded measures.

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 impacts are summarised in Vol 18 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 18 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 Desk based information suggests that the soils/sediments at the site are unlikely to be substantially contaminated and thus are unlikely to pose a risk to construction workers via direct contact pathways. There may however be some minor risks from bacteriological contamination associated with the sewage outfall which could impact them through the ingestion pathway (such risk are easily mitigated through observance of basic hygiene principles).

8.5.9 Given the low risk nature of the site and the measures to be adopted as part of the *CoCP* (Section 9) (such as the use of PPE, risk assessments and welfare facilities), the overall magnitude of the impact to construction workers (both below and above ground) is assessed to be negligible.

8.5.10 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 effect would occur).

UXO

8.5.11 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 Blackfriars Bridge 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.

8.5.12 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.

8.5.13 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

8.5.14 As previously stated it is unlikely that contaminated soils would be encountered during the works at Blackfriars Bridge Foreshore.

8.5.15 In addition there are a number of standard measures within the *CoCP* (Section 9) that reduce the potential for the off-site migration of dusts or vapours for air quality purposes. These would include 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.

8.5.16 As such the impacts to adjacent land users from existing contamination being spread through dust or vapour migration are considered to be negligible.

8.5.17 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 commercial/administrative/retail land and recreational users such as Thames Path and Inner Temple Garden users and a **minor adverse** effect on the residential land-users (although the effect is defined as minor adverse, it is considered unlikely that the effects would occur).

UXO

8.5.18 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.

8.5.19 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 commercial/administrative/retail land and recreational users such as Thames Path and Inner Temple Garden users and a **minor adverse** effect on the residential land-users (although the effect is defined as minor adverse, it is considered unlikely that the effects would occur).

Built environment

8.5.21 Impacts from existing land quality relate to the accidental detonation of UXO during preliminary surveys or main construction works.

8.5.22 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.

8.5.23 With these measures in place the overall magnitude of the impact to the built environment is assessed to be negligible.

8.5.24 Based on the assessed impact magnitude and receptor sensitivity, it is considered that the proposed development would result in a **negligible** effect on the residential, commercial, administrative, retail buildings and river wall and a **minor adverse** effect on the listed structures such as Bazalgettes Embankment, Blackfriars Bridge and other listed structures (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 As described in Section 8.3 there are no schemes in Vol 18 Appendix N which meet the project criteria for inclusion in the cumulative assessment. Therefore no assessment of cumulative effects has been undertaken.

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 18 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, sediments, liquid, 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, sediments, liquids, soil gases / vapours	Minor adverse	None	Minor adverse*
	Health effects from detonation of UXO	Minor adverse	None	Minor adverse*
Adjacent land-users, workers within retail, administrative and 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 users such as Inner Temple Garden users (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 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 –	Damage to structures from detonation of	Negligible	None	Negligible

Receptor (sensitivity)	Effect	Significance of effect	Mitigation	Significance of residual effect
residential/administrative /retail/commercial buildings and river wall (Low)	UXO			
Built environment – listed structures such as Bazalgette's Embankment, Blackfriars Bridge and other listed structures (High)	Damage to structures from detonation of UXO	Minor adverse	None	Minor adverse*

**Although the effect is defined as minor adverse, it is considered unlikely that the effect would occur.*

References

[1] Defra. *National Policy Statement for Waste Water* (2012).

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[3] Environment Agency. *Model procedures for the management of land contamination: Contaminated Land Report 11* (2004).

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Thames Water Utilities Limited

Application for Development Consent

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Environmental Statement

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Volume 18 Blackfriars Bridge Foreshore site assessment

Section 9: Noise and vibration

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Thames Tideway Tunnel

Environmental Statement

Volume 18: Blackfriars Bridge 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 main Blackfriars Bridge Foreshore site and the smaller secondary area of Blackfriars Pier.

9.1.1 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).

9.1.2 Each of these is considered within the assessment. The tunnel drive for the main tunnel runs 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 effects assessment.

9.1.3 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) (Defra, 2012)[1]. Further details of these requirements can be found in Volume 2 Environmental assessment methodology Section 9.3.

9.1.4 Plans of the proposed development as well as figures included in the assessment for this site are contained in a separate volume (Volume 18 Blackfriars Bridge 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.

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 18 Sections 3.3 and 12.2.

Construction activities

9.2.3 Vol 18 Section 3.3 sets out the assumed construction duration and programme for the Blackfriars Bridge Foreshore site.

9.2.4 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 works
d. cofferdam construction
e. diaphragm wall construction
f. shaft construction
g. shaft secondary lining and internals
h. interception and culvert works
i. landscaping (including construction and fit-out of permanent facility).

9.2.5 Further detail on the plant used in these construction stages is given in Vol 18 Appendix G.

9.2.6 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 (core) hours (08.00-18.00 weekdays and 08.00-13.00 Saturdays) as identified in the *Code of Construction Practice* (*CoCP)*.

b. extended working hours (6pm-10pm weekdays, 13.00-17.00 Saturdays) to complete large concrete pours. These are assumed to occur approximately twice a week for two and a half months during the diaphragm wall construction and then once a month for other major concrete pours.

Code of Construction Practice

9.2.7 The *CoCP* is provided in Vol 1 Appendix A. It contains general requirements (Part A), and site specific requirements for this site (Part B).

9.2.8 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.

9.2.9 Site specific measures incorporated into the *CoCP Part B* (Section 6) to reduce noise and vibration effects include:

a. The City of London require the submission of the contractors site-specific Construction and Demolition Statement for agreement. This supersedes the requirement for a separate Section 61 application as required in Section 6.3 of Part A

b. The loading and unloading of barges would be carried out during standard hours only.

Operation

9.2.10 A ventilation structure would be constructed to contain plant and filter equipment and to house the ventilation columns. The plant installed would have the potential to create noise impacts, and these are considered in the assessment.

9.2.11 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

9.2.12 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 Blackfriars Bridge Foreshore, receptors within City of London and receptors on the opposite bank of the Thames which lie within London Borough (LB) of Southwark have been considered (see para 9.3.15). The environmental design measures have considered the following noise sources:

a. hydraulic plant for penstock operation (pumps, motors)

b. uninterruptable power supply (UPS) plant.

9.2.13 In considering the noise from the above items, the sound insulation of the housing for the equipment has been taken into consideration.

9.2.14 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 The survey methodology and monitoring locations, and limits for plant noise due to the operation of the site were agreed with the City of London Corporation.

9.3.3 The LB of Southwark was also consulted with regard to limits for plant noise from the operation of the site, as the Borough is located opposite this site, across the River Thames.

9.3.4 There were no site specific comments from stakeholders in relation to noise and vibration raised at scoping or other consultation stages.

Baseline

9.3.5 The baseline methodology follows the methodology provided in Volume 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. There are no site specific variations for undertaking the construction assessment of this site.

9.3.7 Section 9.5 details the likely significant effects arising from the construction at the Blackfriars Bridge Foreshore site. 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.

9.3.8 The construction noise and vibration assessment has considered the effects across the whole duration of the construction phase and the worst-case predicted 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).

9.3.9 All the schemes outlined in the development schedule (Vol 18 Appendix N) are due to be completed by Site Year 1 of the construction period. However none are considered to be relevant to the construction assessment base case as they are considered adequately represented by receptors which are closer to the site.

9.3.10 The planned development at 1-16 Blackfriars Road is 260m south of the Blackfriars Bridge Foreshore has been included in the cumulative assessment as the construction would occur during the same period. There are no other schemes considered relevant to the construction cumulative assessment as all are assumed to be complete and operational by Site Year 1 of construction and/or are outside of the 300m assessment area.

9.3.11 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 in para 9.5.46.

9.3.12 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

9.3.13 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

9.3.14 The operational phase assessment methodology follows the methodology provided in Volume 2. Site specific variations to this methodology are set out below.

9.3.15 For residential receptors at this site, City of London Corporation and LB of Southwark require that noise emissions from this type of source are designed to meet a rating level (as defined in BS4142[2]) 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.

9.3.16 The operational assessment year is taken to be Year 1 of operation.

9.3.17 Section 9.6 details the likely significant effects arising from the operation at the Blackfriars Bridge 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.

9.3.18 All the schemes outlined in the development schedule (Vol 18 Appendix N) are due to have been completed by Year 1 of the operational period.

9.3.19 There are no developments relevant to the operational cumulative assessment as due to their use, none are expected to generate significant noise or vibration levels during their operation.

9.3.20 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.

9.3.21 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

9.3.22 Operational effects are considered up to 300m from the site boundary, although the focus is on the closest receptors.

Assumptions and limitations

9.3.23 The generic assumptions and limitations associated with this assessment are presented in Volume 2. The site specific assumptions are presented in the following section. There are no site-specific limitations for this site.

Assumptions

9.3.24 The working hours assumed for the assessment are as described in para. 9.2.6.

Limitations

9.3.25 There are no limitations associated with this site-specific noise and vibration assessment.

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 18 Appendix G. Vol 18 Table 9.4.1 shows the measured ambient noise levels for the day, evening and night 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 18 Table 9.4.1 below (and shown in plan view in Vol 18 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 18 Table 9.4.2.

9.4.5 The nearest residences located to the north of the site in the City of London are at 7 -13 Kings Bench Walk, and the nearest residences to the south of the site are at River Court on the south bank of the Thames in LB of Southwark. The non-residential noise sensitive receptors selected for assessment are the offices on Victoria Embankment, including Sion Hall, 40-50 Victoria Embankment, The President and the Unilever Building (including the Crown Plaza Hotel on New Bridge Street) and the Mermaid Conference Centre.

9.4.6 Beyond these closest receptors there are other non-residential locations, which are screened from the site by intervening buildings. This includes the Crown Plaza Hotel which has been considered as a secondary receptor to Unilever House.

Receptor sensitivity

9.4.7 The noise and vibration sensitive receptors have been assessed according to their sensitivity, using the methodology outlined in Volume 2 Section 9.4. The sensitivities of all assessed receptors are presented in Vol 18 Table 9.4.1.

Vol 18 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 dBLAeq*	Noise survey location
BB1	7-13 Kings Bench Walk (residential)	High	City of London Corporation	73/70	BBF01
BB2	40-50 Victoria Embankment (offices)	Medium	City of London Corporation	77/75	BBF02
BB3	Sion Hall (offices)	Medium	City of London Corporation	77/75	BBF02
BB4	60 Victoria Embankment (offices)	Medium	City of London Corporation	73/70	BBF01
BB5	Mermaid Conference Centre (conference centre)	Medium	City of London Corporation	74/72	BBF04
BB6	1-87 River Court (residential)	High	LB of Southwark	66/62	BBF03
BB7	Unilever House	Medium	City of London	73/70	BBF01

Ref	Receptor addresses	Sensitivity	Local authority	Measured average ambient noise level, day/ evening dBLAeq*	Noise survey location
	(offices)		Corporation		
BB8	The President (offices/ function and conference rooms)	Medium	City of London Corporation	77/75	BBF02

* *Noise level includes correction for façade acoustic reflection unless receptor position is an open outdoor space (eg park)*

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 Victoria Embankment site have been identified as shown in Vol 18 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 18 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 18 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	Assessment category* day/ evening	Impact criterion threshold level*, day, dB$L_{Aeq\ 10hour}$/ evening dB$L_{Aeq\ 1hour}$
BB1	7 -13 Kings Bench Walk (10)	75/70	C/C**	75/70
BB6	1-87 River Court (87)	65/60	B/C	70/65

** From 'ABC' method – BS5228:2009*[3]

*** 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 construction base case taking into account the schemes described in Section 9.3 would change as the London River Park would be complete and therefore it has been considered as a receptor in the construction 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). The estimated traffic increases for the construction base case in Site Year 1 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 There are a number of existing vibration sources immediately alongside the Blackfriars Bridge Foreshore site. The London Underground District and Circle lines run to the north of the site under the Embankment and the Waterloo and City line crosses under the site. Furthermore, Network Rail Blackfriars Station is located to the east of the site. These railway alignments have been established for a long period and it is considered that vibration levels are unlikely to change between the present time and the base case.

9.4.15 The President vessel would be relocated a short distance upstream to Chrysanthemum Pier prior to the commencement of construction works, and this location has been used in the assessment of impacts. The development case is therefore assumed to be the base case as identified in 2011 with the relocated President vessel.

Operational base case

9.4.16 The base case in Year 1 of operation takes into account the schemes described in Section 9.3. The President vessel would be relocated back to its original position for the operational case, and therefore it has been assumed to be in its original position for the operational assessment.

9.4.17 The operational base case has been estimated from traffic flow expectations for 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 results of the assessment of construction noise are presented in Vol 18 Table 9.5.1 and Vol 18 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 18 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.

9.5.2 To illustrate the predicted variation in construction noise levels at each receptor position across the duration of the construction phase, Vol 18 Plates G.5 to G.12 in Vol 18 Appendix G show the estimated noise levels plotted month-by-month over the duration of the works. The appendix also lists the construction plant and operations assumed for the calculations.

9.5.3 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 18 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
BB1 / 7 -13 Kings Bench Walk (10)	75	45 – 70 (day)	52	0	-5	0
	70	57 – 60 (eve)	60	0	-10	0
BB6 / 1-87 River Court (87)	70	46 – 62 (day)	55	0	-8	0
	65	56 – 59 (eve)	59	0	-6	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

7 -13 Kings Bench Walk (BB1)

9.5.5 7 -13 Kings Bench Walk are four storey residential buildings, located 55m from the site boundary. All floors of the building would be screened from the majority of the site activities, although the upper floors would have a partial view of the excavated materials handling area. The predicted noise levels at these dwellings due to construction activities are shown in Vol 18 Table 9.5.1.

9.5.6 The typical daytime noise levels (most frequently occurring monthly level) is 52dBL_{Aeq}. The demolition works are expected to cause the worst-case noise level of 70dBL_{Aeq} for two months.

9.5.7 During the evening, shaft excavation and diaphragm wall works are expected to cause the worst-case noise levels of 60dBL_{Aeq} at this receptor.

9.5.8 However, the construction noise levels are not estimated to exceed the potential significance criteria for a residential receptor. The effect is therefore **not significant**.

9.5.9 Other than those assessed there are no other residential properties in the vicinity of this receptor that are close enough to be subject to significant adverse effects.

1-87 River Court (BB6)

9.5.10 1-87 River Court is a ten storey residential building, located more than 200m from the site boundary. The upper floors of the building have a view of the majority of the site activities. The predicted noise levels at these dwellings due to construction activities are shown in Vol 18 Table 9.5.1.

9.5.11 The typical daytime noise level (most frequently occurring monthly level) is 55dBL_{Aeq}. The construction of the cofferdam and shaft works is expected to cause the worst-case noise level of 62dBL_{Aeq}.

9.5.12 During the evening, shaft excavation and diaphragm wall works are expected to cause the worst-case noise levels of 59dBL_{Aeq}

9.5.13 However, the construction noise levels are not estimated to exceed the potential significance criteria for a residential receptor. The effect is therefore **not significant**.

9.5.14 Other than those assessed there are no other residential properties in the vicinity of this receptor that are close enough to be subject to significant adverse effect.

Impacts at non-residential receptors

9.5.15 The results for non-residential receptors are shown below.

Vol 18 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}
BB2 40-50 Victoria Embankment	Medium	50 – 74 (day)	77	62	0	-3
		71 – 74 (eve)	75	74	0	-1
BB3 Sion Hall	Medium	54 – 74 (day)	77	64	0	-3
		71 – 74 (eve)	75	74	0	-1
BB4 60 Victoria Embankment	Medium	57 – 73 (day)	73	61	0	0
		67 – 70 (eve)	70	70	0	0
BB5 Mermaid Conference Centre	Medium	44 – 71 (day)	74	49	0	-3
		48 – 51 (eve)	72	51	0	-21
BB7 Unilever House	Medium	52 – 71 (day)	73	58	0	-2
		64 – 66 (eve)	70	66	0	-4
BB8 President Vessel	Medium	53 – 73 (day)	77	61	0	-4

[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*

40-50 Victoria Embankment (BB2)

9.5.16 The predictions at this location are representative of the four to six storey offices at Hamilton House, Telephone House, Audit House and Carmelite, the closest of which are located approximately 35m from the site boundary. The upper floors of these buildings would have at least a partial view of the site activities.

9.5.17 The typical daytime noise level (most frequently occurring monthly level) is 62dBL_{Aeq}. The highest predicted daytime noise level is shown in Vol 18 Table 9.5.2 which would occur during the construction of the shaft by diaphragm walling. The noise level is 74dBL_{Aeq} during the daytime which is less than the current ambient noise level for the respective period.

9.5.18 During the evening, shaft excavation and diaphragm wall works are expected to cause the worst-case noise levels of 74dBL_{Aeq} at this receptor.

9.5.19 The internal noise levels inside the building are not expected to exceed either the current levels or guideline noise levels for general office use based on typical noise insulation for a façade of this type.

9.5.20 Hence, the noise level at this receptor is not likely to cause disturbance to occupants. This is therefore assessed as **not significant**.

Sion Hall (BB3)

9.5.21 The predictions at this location are representative of the offices at Sion Hall and Sion College, the closest of which are located approximately 35m from the site boundary. The upper floors of these buildings would have at least a partial view of the site activities.

9.5.22 The typical daytime noise levels (most frequently occurring monthly level) is 64dBL_{Aeq}. The highest predicted daytime noise level is shown in Vol 18 Table 9.5.2 which would occur during the construction of the shaft by diaphragm walling. The noise level is 74dBL_{Aeq} during the daytime which is less than the current ambient noise level for the respective period.

9.5.23 During the evening, shaft excavation and diaphragm wall works are expected to cause the worst-case noise levels of 74dBL_{Aeq} at this receptor.

9.5.24 The internal noise levels inside the building are not expected to exceed either the current levels or guideline noise levels for general office use based on typical noise insulation for a façade of this type.

9.5.25 Hence, the noise level at this receptor is not likely to cause disturbance to occupants. This is therefore assessed as **not significant**.

60 Victoria Embankment (BB4)

9.5.26 60 Victoria Embankment is a three storey office building located approximately 40m from the site boundary. The upper floor of this building would have at least a partial view of the worksite activities.

9.5.27 The typical daytime noise levels (most frequently occurring monthly level) is 61dBL_{Aeq}. The highest predicted daytime noise level is shown in Vol 18 Table 9.5.2 which would occur during the construction of the shaft by diaphragm walling. The noise level is 73dBL_{Aeq} during the daytime which is the same as the current ambient noise level for the respective period.

9.5.28 During the evening, shaft excavation and diaphragm wall works are expected to cause the worst-case noise levels of $70dBL_{Aeq}$ at this receptor.

9.5.29 The internal noise levels inside the building are not expected to exceed either the current levels or guideline noise levels for general office use based on typical noise insulation for a façade of this type.

9.5.30 Hence, the noise level at this receptor is not likely to cause disturbance to occupants. This is therefore assessed as **not significant**.

Mermaid Conference Centre (BB5)

9.5.31 Mermaid Conference Centre is a three storey building located approximately 35m from the eastern worksite, but more than 120m from the main worksite. The upper floor of this building would have at least a partial view of the eastern worksite activities.

9.5.32 The typical daytime noise levels (most frequently occurring monthly level) is $49dBL_{Aeq}$. The highest predicted daytime noise level is shown in Vol 18 Table 9.5.2 which would occur during the demolition associated with the relocation of the pier. The noise level is $71dBL_{Aeq}$ during the daytime which is less than the current ambient noise level for the respective period.

9.5.33 During the evening, shaft excavation and diaphragm wall works are expected to cause the worst-case noise levels of $51dBL_{Aeq}$ at this receptor.

9.5.34 During the daytime and evening there is no expected increase in internal noise level. Hence, the noise level at this receptor is not likely to cause disturbance to occupants. This is therefore assessed as **not significant**.

Unilever House (BB7)

9.5.35 Unilever House at 100 Victoria Embankment is an eight storey office building located approximately 40m from the site boundary. The upper floors of this building would have at least a partial view of the worksite activities.

9.5.36 The typical daytime noise levels (most frequently occurring monthly level) is $58dBL_{Aeq}$. The highest predicted daytime noise level is shown in Vol 18 Table 9.5.2 which would occur during the construction of the shaft by diaphragm walling. The noise level is $71dBL_{Aeq}$ during the daytime which is less than the current ambient noise level for the respective period,

9.5.37 During the evening, shaft excavation and diaphragm wall works are expected to cause the worst-case noise levels of $66dBL_{Aeq}$ at this receptor.

9.5.38 The internal noise levels inside the building are not expected to exceed either the current levels or guideline noise levels for general office use based on typical noise insulation for a façade of this type.

9.5.39 Hence, the noise level at this receptor is not likely to cause disturbance to occupants. This is therefore assessed as **not significant**.

9.5.40 To the rear of Unilever House is the eight storey Crown Plaza hotel, which is located more than 120m from the site boundary and is fully screened from the works by the Unilever Building. The current ambient noise level at this receptor would be similar to the level at the Unilever Building.

Given the additional screening, the internal noise levels are unlikely to be affected by the works and the effect is assessed as **not significant**.

The President Vessel (BB8)

9.5.41 The President vessel is used as an office and function venue and is to be relocated to a position approximately 20m from the western end of the site.

9.5.42 The typical daytime noise levels (most frequently occurring monthly level) is 61dBL_{Aeq}. The worst-case predicted daytime noise level is shown in Vol 18 Table 9.5.2 which would occur during the closest cofferdam works, demolition and the material handling activities. This noise level is 73dBL_{Aeq} during the daytime which is less than the current ambient noise level for the respective period.

9.5.43 The internal noise levels inside the building are not expected to exceed either the current levels or guideline noise levels for a restaurant based on typical noise insulation for a façade of this type.

9.5.44 Hence, the noise level at this receptor is not likely to cause disturbance to occupants. This is therefore assessed as **not significant**.

Road-based construction traffic

9.5.45 The location of the site adjacent to Blackfriars Bridge provides direct access to the major road network through London. The construction programme would result in varying traffic generation over a period of five and a half years. During the peak construction period the traffic generation is forecast to average 46 HGVs (equivalent to 92 heavy vehicle movements) per day.

9.5.46 The major road links adjacent to and leading to the site are Victoria Embankment, Upper Thames Street, New Bridge Street, Farringdon Road and Blackfriars Bridge. Vehicles would not use other local roads such as Tudor Street.

9.5.47 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 goods vehicles composition (HGV) of 5% is also considered to cause a change in noise level of 1dB.

9.5.48 The traffic modelling shows that the 18hr flow on the section of Victoria Embankment which is adjacent to the site is currently over 25,000 vehicles per day (vpd), with average speeds of 24 mph (38 kph) and 8.3 % Heavy Goods Vehicles (HGVs). The total number of HGVs is therefore currently over 2,100 per day.

9.5.49 The section of Victoria Embankment to the west of the site has the highest 18hr flow, with over 68,000 vpd and 5.6% HGVs. The 18hr flows on other links are significantly less, with New Bridge Street and Farringdon Road having flows of approximately 40,000 vpd and flows on other links ranging from approximately 25,000 vpd to 30,000 vpd. Two small sections of Victoria Embankment have much lower flows, with the flow on each link being approximately 6,000 vpd. The majority of links have a higher HGV percentage, with several having a significantly higher HGV percentage. In particular, the two small sections of Victoria Embankment have HGV percentages of 16% and 17%.

9.5.50 The modelling of construction traffic on these links shows that the highest percentage increase in total flow due to construction HGVs would occur on Upper Thames Street, which is located to the north east of the site. The current flow is above 25,000 and the average daily number of construction HGV movements on this link during the peak month of construction is 92. This represents a percentage increase in flow of 0.4%.

9.5.51 Additionally, the modelling of the construction traffic on these links shows that an increase in HGV proportion would also occur on Upper Thames Street. The average daily number of construction HGV movements on this link during the peak month of construction is 92, which represents an increase in HGV proportion of 0.3%.

9.5.52 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 cause only negligible change to the traffic noise levels and the effects are assessed as **not significant**.

River-based construction traffic

9.5.53 The movement of these barges would be at appropriate stages in the tide. In between times the moored barges would be unloaded or loaded. Noise measurements for such activity have been reported in other studies[4]. The engine noise from movement of the barges is limited to 75dB(A) at 25m[5].

9.5.54 The operation of the tugs on the river outside of the site boundary have been assessed in relation to the nearest residential receptors, 7 -13 Kings Bench Walk and 1-87 River Court.

9.5.55 At 7 -13 Kings Bench Walk the tugs would operate at a minimum distance of 130m. At this distance the predicted noise from this activity during the day/evening (7am to 11pm) would be 39dBL_{Aeq} at the dwelling. The survey indicates that the daytime noise level at this location is 72dBL_{Aeq}, as identified in Vol 18 Appendix G Table G.8. Therefore the noise from river based construction traffic is considered to be **not significant.**

9.5.56 At 1-87 River Court the tugs would operate at a minimum distance of 120m. At this distance the predicted noise from this activity during the day/evening (7am to 11pm) would be 45dBL_{Aeq} at the dwelling. The survey indicates that the daytime noise level at this location is 63dBL_{Aeq}, as identified in Vol 18 Appendix G Table G.8 which is greater than the tug noise and therefore the noise from river based construction traffic is considered to be **not significant.**

Vibration

9.5.57 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.

9.5.58 The assessment has been conducted using the methodology defined in Volume 2.

9.5.59 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 18 Table 9.5.3.

Vol 18 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**
BB1	7 -13 Kings Bench Walk	<0.3	High	Below 'Low probability of adverse comment' - No impact
BB2	40-50 Victoria Embankment	<0.5	Medium	'Low probability of adverse comment' - No impact
BB3	Sion Hall	<0.4	Medium	Below 'Low probability of adverse comment' - No impact
BB4	60 Victoria Embankment	<0.4	Medium	Below 'Low probability of adverse comment' – No impact
BB5	Mermaid Conference Centre	<0.2	Medium	Below 'Low probability of adverse comment' – No impact
BB6	1-87 River Court	<0.1	High	Below 'Low probability of adverse comment' – No impact
BB7	Unilever House	<0.3	Medium	Below 'Low probability of adverse comment' – No impact
BB8	The President Vessel	<0.4	High	Below 'Low probability of adverse comment' – No impact

**Most affected floor*

** *Predicted vibration levels assume groundborne transmission. For boats/ pontoons moored in the river it is expected that vibration transmission would be reduced and the vibration levels would be lower than those estimated*

9.5.60 The predicted eVDV levels at the residential receptors fall within or below the 'Low probability of adverse comment' band, as described in Volume 2 and therefore significant effects are not anticipated.

9.5.61 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 18 Table 9.5.4.

9.5.62 The highest levels of vibration are associated with the vibratory piling required to start the shaft construction, which would take less than one week to complete, and other vibratory compaction activities which occur throughout the construction programme across the site.

Vol 18 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*
BB1	7 -13 Kings Bench Walk	0.1	High	Below threshold of potential cosmetic damage – No impact
BB2	40-50 Victoria Embankment	0.3	Medium	Below threshold of potential cosmetic damage – No impact
BB3	Sion Hall	0.3	Medium	Below threshold of potential cosmetic damage – No impact
BB4	60 Victoria Embankment	0.3	Medium	Below threshold of potential cosmetic damage – No impact
BB5	Mermaid Conference Centre	0.2	Medium	Below threshold of potential cosmetic

Ref	Receptor	Impact (highest predicted PPV across all activities, mm/s)	Value/ sensitivity	Magnitude*
				damage – No impact
BB6	1-87 River Court	0.1	High	Below threshold of potential cosmetic damage – No impact
BB7	Unilever House	0.2	Medium	Below threshold of potential cosmetic damage – No impact
BB8	The President Vessel	0.3	High	Below threshold of potential cosmetic damage – No impact

* *Predicted vibration levels assume groundborne transmission. For boats moored in the river it is expected that vibration transmission would be reduced and the vibration levels would be lower than those estimated.*

9.5.63 The vibration levels reported here are well below the levels likely to cause cosmetic building damage according to the criteria described in Volume 2.

9.5.64 Vibration effects are **not significant** to any receptors.

Sensitivity test for programme delay

9.5.65 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 18 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 A passive ventilation system is to be installed at Blackfriars Bridge Foreshore and therefore there is no requirement to install active ventilation equipment at this location.

9.6.3 The appropriate emission limits are shown below in Vol 18 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 18 Table 9.6.1 although such equipment would be expected to have a relatively low noise emission (approximately 45dB(A) at 3m).

9.6.4 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 two 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 kiosk and would be shielded with an acoustic surround if necessary to meet the requirements in Vol 18 Table 9.6.1

9.6.5 The prediction method and assumptions are described in Volume 2. Vol 18 Table 9.6.1 shows, for each receptor, that the estimated plant noise level is below the local authority limit or is less than ambient levels for residential and non-residential receptors respectively.

Vol 18 Table 9.6.1 Noise – operational airborne noise impacts

Ref	Receptor	Lowest baseline noise level	Impact	Value/ sensitivity	Magnitude
BB1	7 -13 Kings Bench Walk	63dBL_{A90}, 15 minutes	Plant noise emission rating level at receptor less than 53dBL_{Aeq}	High	Plant noise level below local authority limit*,– no adverse impact
BB2	40-50 Victoria Embankment	77dBL_{Aeq}, 15 minutes	Plant noise emission level at receptor less than 77dBL_{Aeq}.	Medium	Plant noise level below ambient daytime level – no adverse impact
BB3	Sion Hall	77dBL_{Aeq}, 15 minutes	Plant noise emission	Medium	Plant noise level below

Ref	Receptor	Lowest baseline noise level	Impact	Value/ sensitivity	Magnitude
			level at receptor less than 77dBL_{Aeq}		ambient daytime level – no adverse impact
BB4	60 Victoria Embankment	73dB$L_{Aeq,}$ 15 minutes	Plant noise emission level at receptor less than 73dBL_{Aeq}	Medium	Plant noise level below ambient daytime level – no adverse impact
BB5	Mermaid Conference Centre	72dB$L_{Aeq,}$ 15 minutes	Plant noise emission level at receptor less than 72dBL_{Aeq}	Medium	Plant noise level below ambient evening level – no adverse impact
BB6	1-87 River Court	60dB$L_{A90,}$ 15 minutes	Plant noise emission rating level at receptor less than 50dBL_{Aeq}	High	Plant noise level below local authority limit*,– no adverse impact
BB7	Unilever House	73dB$L_{Aeq,}$ 15 minutes	Plant noise emission level at receptor less than 73dBL_{Aeq}	Medium	Plant noise level below ambient daytime level – no adverse impact
BB8	The President Vessel	77dB$L_{Aeq,}$ 15 minutes	Plant noise emission level at receptor less than 77dBL_{Aeq}	Medium	Plant noise level below ambient daytime level – no adverse impact

* *Limit referred to is that identified for the Local Authority in which the receptor is located (see para 9.3.15).*

9.6.6 The results given above in Vol 18 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 receptors, 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 not to result in 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)[6] 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 Blackfriars Bridge 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 18 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 The planned development at 1-16 Blackfriars Road is located 260m to the south of the Blackfriars Bridge Foreshore site, across the river. It is screened by intervening buildings between the two areas. Given the distance and degree of screening, construction effects from this development are unlikely to cause cumulative effects.

9.7.2 None of the other projects described in Section 9.3, are considered relevant to the cumulative assessment at the Blackfriars Bridge Foreshore site as they are assumed to be either complete before the commencement of the works at this site and/or located more than 300m from the site boundary, no cumulative construction noise or vibration effects are predicted.

9.7.3 In the event that the programme for the Thames Tideway Tunnel is delayed by approximately one year, the 1-16 Blackfriars Road development would 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

9.7.4 None of the projects described in Section 9.3, are considered relevant to the operational cumulative assessment at the Blackfriars Bridge Foreshore site 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 not likely to be any significant adverse effects during the construction phase that would require mitigation beyond that already proposed in the *CoCP*.

Operation

9.8.2 The above assessment has concluded that there are not likely to be any significant adverse effects during the operational phase that would require mitigation.

Monitoring

9.8.3 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

9.9.1 As no mitigation measures are proposed, the residual construction effects remain as presented in Section 9.5.

Operational effects

9.9.2 As no mitigation measures are proposed, the residual operational effects remain as presented in Section 9.6.

9.10 Assessment summary

Vol 18 Table 9.10.1 Noise – summary of construction assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Surface construction noise				
BB1 - 7 -13 Kings Bench Walk	Noise	Not significant	None	Not significant
BB2 - 40-50 Victoria Embankment	Noise	Not significant	None	Not significant
BB3 - Sion Hall	Noise	Not significant	None	Not significant
BB4 - 60 Victoria Embankment	Noise	Not significant	None	Not significant
BB5 - Mermaid Conference Centre	Noise	Not significant	None	Not significant
BB6 - 1-87 River Court	Noise	Not significant	None	Not significant
BB7 - Unilever House	Noise	Not significant	None	Not significant
BB8 - The President	Noise	Not significant	None	Not significant
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				
BB1 - 7 -13 Kings Bench Walk	Noise	Not significant	None	Not significant
BB6 - 1-87 River Court	Noise	Not significant	None	Not significant

Vol 18 Table 9.10.2 Vibration – summary of construction assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
BB1 - 7 -13 Kings Bench Walk	Vibration	Not significant	None	Not significant
BB2 - 40-50 Victoria Embankment	Vibration	Not significant	None	Not significant
BB3 - Sion Hall	Vibration	Not significant	None	Not significant
BB4 - 60 Victoria Embankment	Vibration	Not significant	None	Not significant
BB5 - Mermaid Conference Centre	Vibration	Not significant	None	Not significant
BB6 - 1-87 River Court	Vibration	Not significant	None	Not significant
BB7 - Unilever House	Vibration	Not significant	None	Not significant
BB8 - The President	Vibration	Not significant	None	Not significant

Vol 18 Table 9.10.3 Noise – summary of operational assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
BB1 - 7 -13 Kings Bench Walk	Noise	Not significant	None	Not significant
BB2 - 40-50 Victoria Embankment	Noise	Not significant	None	Not significant
BB3 - Sion Hall	Noise	Not significant	None	Not significant
BB4 - 60 Victoria Embankment	Noise	Not significant	None	Not significant
BB5 - Mermaid Conference Centre	Noise	Not significant	None	Not significant
BB6 - 1-87 River Court	Noise	Not significant	None	Not significant
BB7 - Unilever House	Noise	Not significant	None	Not significant

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
BB8 - The President	Noise	Not significant	None	Not significant

Vol 18 Table 9.10.4 Vibration – summary of operational assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
BB1 - 7 -13 Kings Bench Walk	Vibration	Not significant	None	Not significant
BB2 - 40-50 Victoria Embankment	Vibration	Not significant	None	Not significant
BB3 - Sion Hall	Vibration	Not significant	None	Not significant
BB4 - 60 Victoria Embankment	Vibration	Not significant	None	Not significant
BB5 - Mermaid Conference Centre	Vibration	Not significant	None	Not significant
BB6 - 1-87 River Court	Vibration	Not significant	None	Not significant
BB7 - Unilever House	Vibration	Not significant	None	Not significant
BB8 - The President	Vibration	Not significant	None	Not significant

References

[1] Defra. *National Policy Statement for Waste Water* (2012) Available at: http://www.defra.gov.uk/publications/files/pb13709-waste-water-nps.pdf. Accessed November 2012

[2] British Standards Institution, *BS 4142 Method for rating industrial noise affecting mixed residential and industrial areas* (1997)

[3] British Standards Institution, *BS 5228 Code of Practice for Noise and Vibration Control on Open Construction Sites* (2009)

[4] Peter Brett Associates on behalf of Lafarge Cement UK, *Northfleet Works Bulk Aggregates Import Terminal. Document 2h: Environmental Statement Volume 3 Appendices: Appendix D.3*.

[5] Port of London Authority, *Draft Thames Freight Operations Vessel Standards*

[6] 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: **6.2.18**

Volume 18 Blackfriars Bridge Foreshore site assessment

Section 10: Socio-economics

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

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Thames Tideway Tunnel

Environmental Statement

Volume 18: Blackfriars Bridge 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 main Blackfriars Bridge Foreshore site and the smaller secondary area of Blackfriars Pier. At this site effects during construction are considered on users of the Thames Path and Inner Temple Garden, on the users, owner and commercial operators of services to and from Blackfriars Millennium Pier, on The President and on nearby businesses and residents. During the operational phase, effects are considered on users of the Thames Path National Trail and Right of Way (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 18 Blackfriars Bridge 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 Construction of the temporary cofferdam would require the permanent relocation of the Blackfriars Millennium Pier and its mooring facilities to the east of Blackfriars Bridge[i]. The business located on the pier would need to relocate.

10.2.3 Minor works to accommodate the relocation of the pier would include a new landing just off the Thames Path and two new temporary pedestrian elevators to provide full access between Blackfriars Bridge and the relocated pier.

10.2.4 Temporary closure of the part of the Thames Path would be required and a temporary diversion would be put in place.

10.2.5 The vessel The President would need to be temporarily relocated west to Chrysanthemum pier.

10.2.6 The westbound road ramp, which carries traffic from the Blackfriars Bridge/New Bridge Street/Queen Victoria Street intersection to Victoria Embankment, would be closed, partially removed and reinstated on completion. This would remove the ramp from use by traffic.

10.2.7 The works would also block access to and therefore require the relocation of a specialist sports facility located under the ramp.

10.2.8 Works at the site are expected to last approximately five years. For detail on construction working hours, see Section 3.3 of this volume

10.2.9 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

10.2.10 Construction is expected to require a maximum workforce of approximately 70 workers at any one time. The number and type of workers is shown in Vol 18 Table 10.2.1 .

Vol 18 Table 10.2.1 Socio-economics – construction worker numbers

Contractor		Client
Staff*	Labour**	Staff
08:00-18:00	08:00-18:00	08:00-18:00
30	30	10

**Staff Contractor – engineering and support staff to direct and to project manage the engineering work and 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.*

[i] The effect of this permanent change is considered under the construction phase effect assessment and is not reconsidered within the operational phase effect assessment.

Code of Construction Practice

10.2.11 Measures applicable to all sites incorporated into the *Code of Construction Practice (CoCP)*[ii] to limit significant adverse air quality (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.

10.2.12 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[iii] 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*).

10.2.13 Further site specific measures, which could reduce socio-economic effects and particularly amenity effects, are incorporated into the *CoCP*. 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.

10.2.14 The *CoCP Part B* includes provision for coordination with the City of London Corporation and Transport for London (TfL) on the requirements for pedestrian routes to the relocated Blackfriars Pier and ensuring the publicising and adequate signage of these changes (see Section 5 within the *CoCP part B*). The *CoCP part B* also makes provision for ensuring that the Thames Path diversion would be adequately signed (see Section 5 within the *CoCP Part B*).

Operation

10.2.15 The requirement for above-ground structures in the operational phase is described in Section 3 of this volume, and would result in the extension of the existing river wall out into the River Thames. This would create a new area of public amenity space at the same level as the existing Thames Path available for passive recreational use by the public.

10.2.16 The Blackfriars Millennium Pier, relocated to the east of Blackfriars Bridge during the construction phase, would remain permanently in its new position.

10.2.17 The President would be relocated to its original mooring after the completion of the construction.

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

[iii] 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.

Environmental design measures

10.2.18 Measures which have been incorporated into the design of the proposed development (described in the design principles) include the:

a. diversion of the Thames Path over the new foreshore structure, to a minimum width of four metres

b. creation of a viewing platform by raising the western end of the foreshore structure

c. provision of an amenity building (to be operated by others) to help animate the structure

d. planting of semi mature London plane trees along Victoria Embankment

e. provision of a landscape design which encourages informal play, possibly including a water feature.

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 here.

10.3.2 All consultee comments relevant to this site are presented in the table below.

Vol 18 Table 10.3.1 Socio-economics – stakeholder engagement

Organisation	Comment	Response
City of London Corporation (May, 2011)	The environmental impact assessment (EIA) should include issues affecting the City Riverside Walkway	Consideration of effects on users of the Thames Path is included in this socio-economic assessment.
Greater London Authority (including Transport for London), (Feb, 2012)	The impact of the proposed diversion of the Thames Path will need assessing and appropriate mitigation put forward, including pedestrian crossings, diversionary signage etc which will need to be discussed further with TfL.	Safe pedestrian crossing facilities and diversionary signposting, etc, for diverted sections of the Thames Path is provided for within Section 5.3 of the *CoCP Part A*. Consideration of effects on users of the Thames Path from the diversion of the Thames Path is included in this socio-economic assessment.

Organisation	Comment	Response
Greater London Authority (including Transport for London), (Feb, 2012)	Thames Water should be aware that TfL has a tenant within the existing pump-house at Blackfriars Pier. Alternative accommodation for the tenant would need to be provided within the same vicinity. It may be possible to provide some office accommodation as part of the new pier facilities.	Consideration of the effects on the commercial tenant within the existing pump-house at Blackfriars Pier has been considered within this assessment.
City of London Corporation (Oct, 2012)	The construction and operational phases could give rise to noise and other nuisances for adjacent occupiers. Occupiers that could be impacted include businesses, residents, schools and transport providers. Detailed analysis would need to be made of likely impacts and the mitigation measures required. For example the operational hours of the school, public exam periods etc.	Where appropriate, consideration of amenity effects on surrounding potentially sensitive receptors has been included within this socio-economic assessment. The method by which receptors were identified is set out within the socio-economic assessment methodology (see Vol 2 Section 10).

Baseline

10.3.3 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

10.3.4 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.

10.3.5 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 for this site. An effect assessment on the amenity of users of Inner Temple Gardens has been undertaken although it does not meet the criteria for identification as a receptor for such effects. It has been included however due to its proximity to the site and the size of the public open space that it offers within the local catchment area.

10.3.6 Section 10.5 details the likely significant effects arising from the construction at Blackfriars Bridge Foreshore. Another nearby Thames Tideway Tunnel project site which could give rise to additional effects at this site on the Thames Path is Victoria Embankment Foreshore. Consideration of the effects on the Thames Path at that site is therefore included in this assessment.

10.3.7 Of the developments listed in the site development schedule (see Vol 18 Appendix N), there is only one which is considered relevant as a receptor for the construction base case assessment. The development is Puddle Dock Mermaid Theatre site, which is located approximately 100m to the north amd would involve provision of a new seven storey hotel. This development would alter the baseline by adding a potentially sensitive receptor within 250m of the site (the new hotel) in the construction base case. The other developments are located beyond the assessment areas relevant to the respective assessments undertaken for this site.

10.3.8 Of the developments listed in the site development schedule (see Vol 18 Appendix N), there is one which would be under construction at the same time as the Thames Tideway Tunnel project at this site (1-16 Blackfriars Road), however it is not considered relevant to the assessment as it is located outside of the 250m assessment area. Therefore, no cumulative effects would arise at this site.

Operation

10.3.9 The base case is Site 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 Blackfriars Bridge Foreshore. Another nearby Thames Tideway Tunnel project site which could give rise to additional effects at this site on the Thames Path is Victoria Embankment Foreshore. This site is therefore included in this assessment.

10.3.12 Of the developments listed in the site development schedule (see Vol 18 Appendix N), there are none would introduce new receptors into the operational base case; significantly alter circumstances for those receptors covered by the operational assessment; or 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 affect those users.

Assumptions and limitations

10.3.13 The assumptions and limitations associated with this assessment are presented in Volume 2. The following assumptions are specific to the assessment of this site.

Assumptions

10.3.14 It is assumed that The President (a river hospitality venue business) is going to be relocated a short distance upstream to Chrysanthemum Pier moorings for the duration of the works but would relocate back to its current mooring after construction is complete.

10.3.15 It is assumed that the specialist sports facility clubs would vacate the venue three months before the commencement of the Thames Tideway Tunnel construction works at this site.

Limitations

10.3.16 There are no 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. Future baseline conditions (base case) are also described.

Local context

10.4.2 The site is situated on the southern edge of the City of London; the UK's premier financial services centre. As such the immediate local area within 250m of the site is predominantly comprised of high density commercial (mainly office) land uses. There are limited residential premises as well as a small number of educational, community and recreational land uses, including Inner Temple Garden (see Vol 18 Figure 2.1.2 in separate volume of figures). Within 1km of the site, land uses similar to those within 250m continue further towards the north. On the south bank of the Thames there is a mixture of commercial, institutional, cultural and residential land uses.

Community profile

10.4.3 A detailed community profile is outlined in Vol 18 Appendix H.1[iv]. The following points provide a summary of the community profile and provide context for this socio-economic assessment:

a. The resident population was approximately 550 within 250m of the site and approximately 12,500 within 1km at the time of the last census for which data is available[v].

b. Within 250m (10.8%), 1km (11.0%) and the City of London (9.4%), the proportion of under 16 year olds is approximately half that of the Greater London average (20.2%).

c. Within 250m, the proportion of over 65 year olds (8.0%) is somewhat lower than within 1km (10.5%) and moderately lower than across Greater London (12.4%).

[iv] Information sources are provided in the appendix.

[v] Census 2001. This type of data for the 2011 Census had not been released at the time of the assessment.

d. Within 250m, White residents comprise over four fifths of the population (78.4%) which is somewhat higher than the Greater London average (71.2%). The proportion of Black and Minority Ethnic (BME) residents living within 250m is correspondingly lower.

e. Within 250m, Black residents make up the largest minority group (11.0%). This proportion of Black residents within 1km is similar but in both areas it is over four times higher than within the City of London (2.4%).

f. Approximately 15.3% of residents within 250m have a long term or limiting illness. This is slightly higher than within both 1km (14.6%) and the City of London (13.3%). The number of residents who claim disability living allowance within 250m (5.5%) somewhat higher than within Greater London overall (4.5%).

g. General health surrounding the site is fair compared to the average for Greater London. The local area has low levels of adult and child obesity, despite both adults and children within the City of London having some of the lowest rates of physical activity relative to other adults and children in Greater London. Death rates caused by major illnesses within the City of London are low relative to Greater London. Similarly, male and female life expectancy is relatively high.

h. A high proportion of households within 1km do not own cars (64.1%), somewhat higher than within 250m (50.3%). These rates are considerably higher than the Greater London average (37.5%).

i. There is a very low incidence of income deprivation and overall deprivation (0.0% within 250m and only 2.2% within 1km for both indicators) within the local population. Income deprivation and overall deprivation within Greater London (30.8% and 24.5% respectively) are considerably higher than within 250m and 1km.

10.4.4 The above profile indicates that the surrounding community has a relatively low proportion of children and that residents are predominantly White. Residents generally experience good health and have high life expectancy. Residents also experience lower than average levels of deprivation.

Economic profile

10.4.5 A local economic profile (based on 2012 data) is outlined in Vol 18 Appendix H.2. The following points provide a summary of the profile and provide context to this socio-economic assessment:

a. Within 250m of the site there are approximately 23,900 jobs and 1,100 businesses[vi].

[vi] 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 250m are; Professional Scientific and Technical Activities; Wholesale, and Retail Trade; and Information and Communication.

c. The three largest sectors as measured by number of businesses within 250m are; Professional Scientific and Technical Activities; Administrative; and Financial and Insurance Activities. This reflects the location of the site on the edge of Greater London's main commercial centre.

d. At all geographical levels, the majority of businesses fall within the smallest size band (1 to 9 employees). However, businesses within both 250m and the City of London are on average larger, in terms of the number of employees, than for Greater London overall.

e. Across each of the leading sectors measured by employment and number of businesses within 250m, the majority of businesses are small (having less than 25 employees). In the Professional, Scientific and Technical Activities sector, this is less true as a sizable minority employ in excess of 50 employees.

Receptors

Thames Path

10.4.6 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 runs on both sides of the river. At this location, the Thames Path runs immediately alongside the river wall and is also known as Paul's Walk. From a point approximately 100m to the west of Blackfriars Bridge, the Thames Path splits into two with one part ramping up to Blackfriars Bridge and the other part continuing at river bank level and continuing under Blackfriars Bridge to the east.

10.4.7 Vol 18 Figure 10.4.1 (see separate volume of figures) shows the location of this receptor.

10.4.8 The Thames Path is of good width and well maintained although there are no large trees along the path east of Temple Avenue. There are views across the River Thames to Sea Containers House and the OXO Tower.

10.4.9 To the east of Blackfriars Bridge, the path passes under Blackfriars Station which was recently reconstructed as part of the Thameslink Programme and which now extends across the River Thames.

10.4.10 The usage surveys (see Vol 18 Appendix H.3) recorded a peak usage of 920 movements per hour during the weekday surveys. A mix of commuters and recreational users use the path. During lunchtime and peak evening travel periods there appeared to be a considerable number of local office workers and the path appeared to be well used by tourists.

10.4.11 The usage survey results (see Vol 18 Appendix H.3) are corroborated by pedestrian surveys (see Section 12 of this volume). These recorded a peak hourly usage of 440 pedestrians westbound and 235 eastbound (ie, 675 movements in total) during the PM peak hour. On the basis of this data, it is concluded that the Thames Path is well used at this location.

10.4.12 The main factor affecting the sensitivity of Thames Path users to access restrictions is the availability of alternative routes. Relevant to this are:

a. The Thames Path is a metropolitan wide recreational asset and users have access to many alternative and comparable stretches of the Thames Path on both sides of the river across west and central London, including the stretch of the Thames Path on the opposite side of the river along the south bank.

b. More locally, with regard to the section of the path that runs past the site, there is an alternative route available on the opposite side of Victoria Embankment and around the Blackfriars Bridge Road interchange. The ability of users to access this route is partly hampered by the presence of Blackfriars Bridge, with level changes and stairs meaning that the route is not fully accessible to all users.

10.4.13 In considering the sensitivity of users to amenity related impacts, users of the Thames Path are likely to be near the site for the time that it takes them to walk or cycle past (likely to a few minutes for most). Therefore, the duration for which users could experience impacts would be limited.

10.4.14 Taking the above considerations into account, it is concluded that the sensitivity of Thames Path users is low.

Public amenity space (future) associated with the Thames Path

10.4.15 A new area of public amenity space would be created in the operational phase.

10.4.16 In terms of the value of the new space and the consequent sensitivity of users, the availability of alternative similar spaces is a key factor to consider.

10.4.17 There are only a limited number of public open or amenity spaces accessible in the western portion of the City of London surrounding the site or on the south bank of the river directly opposite. Additionally, the Thames Path at this location is mainly a thoroughfare with limited opportunities for sitting out and taking in views over the River Thames. Furthermore, access to public amenity space in central London is generally at a premium. Additional public amenity space would be well used.

10.4.18 Taking these factors into account, it is considered that users of a future riverside public amenity space would have a medium level of sensitivity.

Blackfriars Millennium Pier

10.4.19 The Blackfriars Millennium Pier is part of a network of piers serving passenger services along the River Thames and mostly provides for commuter peak hour passenger services to and from other destinations up and downstream.

10.4.20 Vol 18 Figure 10.4.1 (see separate volume of figures) shows the location of this receptor.

10.4.21 The Pier is owned and operated (along with seven other passenger piers on the River Thames) by London River Services Limited (LRS), which is a wholly owned subsidiary of TfL (TfL, 2011)[2]. The pier is the only one in the City of London served by the Thames Clippers service (City of London Corporation, 2012)[3] and is served by:

a. Complete Pleasure Boats Ltd – which, as of early 2012, operates peak weekday services to Putney under the name Thames River Taxi (*TfL, 2012)*[4]*.*

b. Thames Executive Charters – which operate sporadic services to and from the pier during special events, eg, the Chelsea Flower Show (*Thames Executive Charters, 2012)*[5].

c. Thames Clippers – which operate commuter river bus services between Embankment and Woolwich Arsenal, and between Bankside and St George's Wharf. The services only stop at Blackfriars from Monday to Friday during morning and evening peaks, except for a limited hourly inter peak service on the Embankment to Woolwich Arsenal route. No services call at Blackfriars Pier on weekends (*Thames Clipper, 2012)*[6].

10.4.22 The latest available data show that over 49,000 passengers departed from Blackfriars Pier in the 2008/09 financial year. Passenger numbers appear to have risen steadily from earlier in the decade (City of London Corporation, 2012).

10.4.23 The main factor affecting the sensitivity of the operator of the Blackfriars Millennium Pier and the operator of services that call at the pier to its relocation is the availability of an alternative location and their ability to operate viably from a new location. Relevant considerations to this are:

a. In terms of the availability of comparable locations a position just downstream of Blackfriars Bridge is available.

b. It is one of two piers located in positions able to serve the City of London (the other being Tower Millennium Pier) and as such it is likely to be an important facility for the pier owner and service operators.

10.4.24 Taking the above factors into account, it is concluded that the sensitivity of the pier owner and service operators to its relocation is medium.

Business - Crown River Cruises office

10.4.25 Crown River Cruises operates an office situated at the old pump house on Blackfriars Millennium Pier. It functions as the administrative office of their river cruise business and there are two employees on site meaning that the operations on the site are equivalent to a micro (one to nine employees) enterprise. The office is relatively small, estimated to be less than approximately 100m^2.

10.4.26 Vol 18 Figure 10.4.1 (see separate volume of figures) shows the location of this receptor.

10.4.27 With regard to the sensitivity of Crown River Cruises, the most critical issue is their capacity to find alternative accommodation of a similar kind to the pump house (ie, accommodation available at a similar or lower cost to the business so as not to affect the business' overall viability). It is understood that the business does not need to be physically located on the river nor does it derive a particular commercial benefit from its current location on the pier (for instance the business does not conduct ticket sales from this location). However, it is also understood that there is some practical benefit for the business from being proximate to the river.

10.4.28 In the City of London, where the site is located, it was estimated that around 10.4% of office floorspace was vacant at the end of 2009 (City of London, 2010)[7]. Given the size of the City of London office market, this indicates a moderate level of office floorspace availability. Therefore, a range of alternative office locations in proximity to the river are likely to be available, although the cost of affordable accommodation may be challenging.

10.4.29 Taking account of the above, the sensitivity of Crown River Cruises to the loss of the Pump House office facility is considered to be medium.

Business – The President

10.4.30 The President is a vessel moored approximately 20m to the west of the proposed development. It is mainly an event and function venue and has several function rooms, external decks and bars that can be hired for corporate and private functions. While the precise number of regular employees of The President's event venue business is not known, it is estimated that the business is equivalent to a small (ten to 49 employees) size enterprise. It may employ additional staff on a part time basis to service the function market, particularly during peak seasons.

10.4.31 The President vessel also accommodates several incubator type small office units. These are located within its lower decks which have been converted with the removal of the boat engines. It currently houses 11 separate businesses and approximately 30 employees in total. Facilities such as meeting rooms are shared between the businesses.

10.4.32 Vol 18 Figure 10.4.1 (see separate volume of figures) shows the location of this receptor.

10.4.33 It is likely that a proportion of The President's customers are corporate clients and organisations from the City of London Corporation and that it attracts custom as a result of its situation. The President, by virtue of its mooring position, enjoys good views along the River Thames.

10.4.34 The main factor affecting the sensitivity of The President to temporary relocation to an alternative mooring is the availability of alternatives moorings and its ability to continue to operate viably from an alternative location. Relevant considerations are:

a. The President is an event business and is understood to rely on pre-booked functions. As such, it is likely that the President would be able to 'carry' its customers with it to a new location, assuming that location was comparably accessible. It would therefore be less sensitive to being displaced relative to a business that is more dependent on passing trade. However, this would be dependent on the availability of an alternative location and its relative accessibility for customers.

b. In terms of the availability of comparable locations it is understood that the Chrysanthemum Pier, located a short distance upstream, could offer a potential temporary mooring for The President.

10.4.35 The sensitivity of The President to amenity effects is linked to the sensitivity of its customers to amenity effects. If customers were sufficiently deterred from booking events / functions on the vessel by impacts such as noise, dust or unpleasant views, then the businesses could suffer deterioration in trade. However, most of the event facilities are located inside the boat rather than on-deck and so exposure to certain effects such as noise and some visual effects would be somewhat limited.

10.4.36 In terms of the sensitivity of employees working at the vessel's dining and event business, the hotel, catering and leisure industry typically employs high rates of part time staff and has one of the highest UK labour turnover rates (People1st, 2011)[8]. Although the precise nature of the small office unit based businesses is not known, it is considered that staff turnover within those businesses would be comparatively lower.

10.4.37 Taking the above factors into account, it is concluded that the sensitivity of The President and the businesses on board to its temporary relocation to an alternative nearby mooring, and of the event and function venue business to amenity effects, is medium.

Business – conference centre and hotel

10.4.38 The Mermaid Conference Centre is located approximately 100m north of the site. The existing building is three storeys. The neighbouring site (Puddle Dock Mermaid Theatre) is also currently subject to a development application to erect a new seven storey hotel alongside (as noted in Section 10.3).

10.4.39 Vol 18 Figure 10.4.1 (see separate volume of figures) shows the location of this receptor.

10.4.40 The Mermaid Conference Centre offers event services and space for hire as well as catering services (The Mermaid Conference Centre, 2012)[9]. The hotel would offer overnight accommodation.

10.4.41 The main factor affecting the sensitivity of the conference centre and hotel to amenity impacts is the degree to which their customers may be deterred from using their services and premises by amenity impacts such as noise, dust or unpleasant views. If customers are sufficiently deterred from using the venue's facilities or from staying at the hotel then the business could suffer deterioration in trade which in turn could lead to a reduction in the number of people employed at the business. However, the indoor nature of the conference centre and hotel would limit exposure to certain effects such as noise. In terms of the sensitivity of the business's employees, the hotel, catering and leisure industry typically employs high rates of part time staff and has one of the highest UK labour turnover rates.

10.4.42 Given the nature of the facilities and the fact that the majority of their activities take place inside, it is considered that the overall sensitivity of the Mermaid Conference Centre and a future hotel alongside it on the Puddle Dock Mermaid Theatre site would be medium.

Specialist sports facility user clubs

10.4.43 A specialist sports facility is located below the down ramp a short distance to the west of Blackfriars Bridge. Vol 18 Figure 10.4.1 (see separate volume of figures) shows the location of this receptor.

10.4.44 It is understood that up to nine different clubs, with approximately 300 members, make use of the facility. It is not known how regularly members attend. It is understood that, following the expiration of their previous lease, the clubs are in the process of negotiating a renewed short term lease which would allow them to remain in their present location until approximately three months before construction of the Thames Tideway Tunnel commences at this site.

10.4.45 With regard to the sensitivity of users of the facility, the most critical issue is the availability of alternative comparable facilities and the clubs' capacity to cope with any impacts from the potential loss of access to the facility. It is understood that the sports facility is used by the nine different clubs partly as a consequence of other alternative facilities closing down and similar facilities becoming increasingly scarce.

10.4.46 Two of the clubs have been using the facility temporarily while a new one is constructed for them in the London Bridge/Bankside area. Planning permission has been approved for this new facility. Once this new facility is constructed, these two clubs will relocate. However, it is understood that the London Bridge facility would not have sufficient capacity to serve as an alternative for the other clubs as well. Therefore, it would meet the needs of only some of the clubs and their members.

10.4.47 Taking account of the above factors, the sensitivity of the users of the clubs to the loss of the facility is considered to be medium.

Open space – Inner Temple Garden

10.4.48 Inner Temple Garden is situated approximately 25m northwest of the site across the Victoria Embankment dual carriageway. It forms the easternmost section of the Victoria Embankment Gardens, which front Victoria Embankment between Blackfriars Bridge and Westminster Bridge. The garden is approximately 1.2ha in size and categorised as a small open space that typically serves a local catchment of less than 400m under The Mayor's Public Open Space Hierarchy (GLA 2011)[10].

10.4.49 Vol 18 Figure 10.4.1 (see separate volume of figures) shows the location of these receptors.

10.4.50 The garden is open to the public on a limited basis between 12.30pm and 3.00pm each weekday. The garden also occasionally holds formal open days allowing visitors access for the whole day. Observations of the gardens have indicated that it is well used in warmer months when it is open. Users appeared to be a mix of office workers and tourists, using the gardens mainly to sit out and to eat lunch.

10.4.51 The garden is of high quality in terms of its design and maintenance. However, the garden is located adjacent to Victoria Embankment, a four lane road, and traffic noise can be heard, particularly from the southern part of the garden.

10.4.52 With regard to the sensitivity of users of the garden and park, the most critical issue is the availability of alternatives and users' capacity to cope with any impacts that could result in a loss of amenity. In this respect, the garden is one of a limited number of accessible open spaces in the southern portion of the City of London of this size, nature and quality. Accordingly users would have few comparable alternatives available to them. However, Inner Temple Gardens is not a fully publicly accessible open space and access to it is managed. The limited opening hours, and the limits this places on public accessibility, are an additional valid consideration.

10.4.53 Taking account of these factors, the sensitivity of the users of the Inner Temple Garden is considered to be medium.

Residential

10.4.54 There are existing residential developments near the proposed construction site as identified in the air quality, noise and vibration and townscape and visual assessments.

10.4.55 Land that is predominantly used for residential development is shown in the land use plan for this site; see Vol 18 Figure 2.1.2 (separate volume of figures).

10.4.56 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.

10.4.57 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

10.4.58 A summary of receptors as described in the baseline and their sensitivity is provided in Vol 18 Table 10.4.1.

Vol 18 Table 10.4.1 Socio-economics – receptor values/sensitivities

Receptor	Value/sensitivity and justification
Users of the Thames Path	Low – alternatives to this section of the Thames Path, both in terms of its role as a metropolitan recreational asset and as a local pedestrian route, are available.
Users of the public amenity space (future) associated with the Thames Path	Medium – some availability of amenity space in association with the Thames Path on both sides of the river, but other opportunities for passive recreation within 400m are relatively limited.
Blackfriars Millennium Pier – pier owner and	Medium – the pier is one of only two located in a position able to serve the City of London but an alternative is available

Receptor	Value/sensitivity and justification
service operators	
Business – Crown River Cruises office	Medium – office vacancy rates in the City of London indicate a relatively moderate availability of alternative office accommodation; although the cost acquiring or renting a new space may prove challenging.
Business – The President	Medium – understood to be an available alternative mooring close by offering similar characteristics to the current mooring. The business could be sensitive to any deterioration in trade caused by amenity effects although most of its dining and function spaces are located indoors.
Business – conference centre and hotel	Medium – if customers were sufficiently deterred from using the conference centre facilities or staying at the hotel by amenity impacts then the business could suffer deterioration in trade. This could in turn affect employees although the hotel sector typically experiences high staff turnover.
Users of the specialist sports facility	Medium – lack of alternative locations for clubs and members. Two of the clubs using the facility will relocate to a new facility in the London Bridge/Bankside area; however, this is unlikely to be able to serve the other clubs.
Users of open space – Inner Temple Garden	Medium – the garden is one of the largest open spaces in the local area and there are few comparably sized and equipped alternative spaces. Sensitivity of users is however limited by the managed access and restrictive opening hours that apply.
Residents	Medium / High – residents would have limited opportunity to avoid effects. They would have medium sensitivity to amenity effects overall during the day but would have high sensitivity to amenity effects overall during the evening and night.

Construction base case

10.4.59 The construction assessment year and area are as set out in para. 10.3.4. The base case in the peak year of construction taking into account the schemes described in Section 10.3 would differ from the baseline in the following ways:

a. The completion of the Blackfriars Railway Bridge and upgraded station, together with the associated upgrade of the Thameslink service, will enhance the capacity, quality and frequency of public transport services to the immediate area (Thameslink Programme, 2011)[11].

b. The development on the Puddle Dock Mermaid Theatre site would result in the establishment of a new hotel 100m from the site. As this development would be constructed alongside the Mermaid Conference Centre, the sensitivity of this receptor has been presented in the baseline above together with that receptor.

10.4.60 Despite a currently expired lease, it is assumed that the specialist sports facility clubs would continue to use the specialist sports facility until three months before the commencement of the Thames Tideway Tunnel construction works at this site, when they would vacate the site.

10.4.61 Other than the above developments, it is assumed that the base case socio economic conditions at the site would remain largely the same as the existing baseline conditions.

Operational base case

10.4.62 The operational assessment year and area are as set out in para. 10.3.9. There would be no changes and so the base case in Year 1 of operation, taking into account the schemes described in Section 10.3, would not change beyond that set out for the construction base case above.

10.5 Construction effects assessment

Temporary diversion of the Thames Path

10.5.1 As set out under the development case, the project would require the temporary closure of the Thames Path and the creation of a diversionary route.

10.5.2 The magnitude of the impact is influenced by the following factors:

a. Usage surveys indicate that the diversion would affect high numbers of users. A proportion would be occasional recreational users, including tourists.

b. The diversion would occur over a long term period of five years but it would be fully reversible after the construction phase.

c. The road layout and level changes at the intersection of Victoria Embankment, New Bridge Street and Blackfriars Bridge make the diversion route relatively extensive. It would add as much as 400m to a typical journey in either direction along the path. At an average walking speed of 4.8km per hour, it would add between four and five minutes to journey times, or approximately five to 10 minutes including additional time waiting to cross roads.

d. The diversion would divert users away from the river and past a busy road junction. However, the quality of the paths along the diversion route is relatively good. Adequate signage, publicity and safety measures, as set out in the *CoCP*, and the temporary provision of elevators along the diverted route would ensure that the Thames Path detour would be clearly navigable and fully accessible.

e. The diversion would mean that the public toilets, accessible via the lower level Thames Path west of Blackfriars Bridge, would be inaccessible to the public during construction.

f. Other sections of the Thames Path, particularly along the South Bank, would provide comparable walking routes for recreational users during the works. It is considered that most commuter users of the path would generally be to be able to use the diversion or find a suitable alternative route.

10.5.3 On the basis of the above analysis, in particular the high number of people affected, extra length of the diversion and duration of time for which it would be in place, it is assessed that the magnitude of impact would be medium.

10.5.4 Given the medium magnitude of impact and the low sensitivity of Thames Path users, the effect of the temporary diversion of the Thames Path would be **minor adverse**.

10.5.5 There is potential for additional effects on users of the Thames Path due to the diversion of the Thames Path at the Victoria Embankment Foreshore site (approximately 1,500m upstream of the site) during construction of that site. Users of both sections of the Thames Path would be diverted twice along a pathway that would ordinarily take approximately 20 to 25 minutes to walk from one end to the other. Both diversions involve crossing to the other side of the road (see Vol 17 Victoria Embankment Foreshore) meaning the diversions would increase walking time accordingly.

10.5.6 The degree to which this would increase the significance of the effect depends on the proportion of users that are likely to walk the length of the Thames Path between the two sites and be subject to both diversions. Based on observations made during the usage surveys, it is estimated that approximately half of all users of either section would be affected by both diversions. However, given that in both cases users would be diverted along the opposite side of the same road, and that the assessment in Vol 17 Section 10 also found that the diversion there would not cause a significant effect for users, it is considered that there would be no additional effect on users.

Effect on pier owner and service operators due to relocation of Blackfriars Millennium Pier

10.5.7 The Blackfriars Millennium Pier would be relocated a short distance downstream to Chrysanthemum pier as a result of the proposed works.

10.5.8 The magnitude of the impact is influenced by several factors.

a. The impact in terms of the pier's new position would be long term and permanent.

b. The effect on the pier owner and the service operator businesses of relocating could be potentially significant as there would be costs and expenditure associated with the move including but not limited to relocation expenses, legal and surveyor fees, taxes, costs of securing and adapting a new position for the pier. Given the proximity of the new location, it is unlikely that relocation would jeopardise the operational viability for the pier owner or service operator.

c. However, in accordance with the *Thames Tideway Tunnel compensation programme* (included within Schedule 2 of the *Statement of Reasons*, which accompanies the application) compensation would be available. Given that Thames Water would comply with the provisions of the compensation programme, it is assumed for the purposes of this assessment that reasonable costs and expenditure incurred by the pier owner and service operators in association with the move would be met. Despite this, there may be some inconvenience involved due to the time required to manage the move for the pier owners and service operators.

10.5.9 Taking account of the above, it is considered that the magnitude of the impact would be low.

10.5.10 Given the low magnitude of the impact and the medium sensitivity, it is assessed that the effect on the pier owner and service operators due to the relocation of Blackfriars Millennium Pier would be **minor adverse**.

Effect on business located on Blackfriars Millennium Pier due to the pier's relocation

10.5.11 The occupier of the office, Crown River Cruises, currently situated on Blackfriars Millennium Pier would be displaced and relocated as a result of the proposed works.

10.5.12 The magnitude of the impact is influenced by several factors.

a. The impact would be permanent.

b. It is understood that the business does not derive a particular commercial benefit, nor operational benefit, from its current location on the pier. At this stage, no alternative premises for the office to relocate to have been identified. Relocation may cause some inconvenience to the two people who are employed by the business on this site, although this would depend on the location of the new office.

c. The effect on the business of relocating could be potentially significant as there would be costs and expenditure associated with the move including but not limited to removal expenses, legal and surveyor fees, taxes, costs of securing and adapting new premises, and temporary loss of profits during the period of the move, and potentially diminution of goodwill following the move. However, as an administrative office, it is unlikely that relocation would jeopardise the operational viability of the office or the business.

d. However, in accordance with the *Thames Tideway Tunnel compensation programme* (included within Schedule 2 of the *Statement of Reasons*, which accompanies the application), compensation would be available. Given that Thames Water would comply with the provisions of the statutory compensation code, it is assumed for the purposes of this assessment that reasonable costs and expenditure incurred in association with the move would be met.

10.5.13 Taking account of the above, it is considered that the magnitude of the impact would be low.

10.5.14 Given the low magnitude of the impact and the medium sensitivity of the business, it is assessed that the effect on Crown River Cruises of relocating their office would be **minor adverse**.

Displacement of moored business – The President (vessel based hospitality venue)

10.5.15 The vessel The President would be temporarily relocated approximately 100m upstream to the vacant Chrysanthemum Pier moorings for the duration of the construction works.

10.5.16 The magnitude of the impact is influenced by several factors:

a. The duration of the relocation period would be approximately five years and The President would return to its original location after the completion of construction works. This constitutes a long term impact.

b. Assuming that The President can be relocated to the Chrysanthemum moorings, the impacts associated with the relocation would be contained and very limited. Whatever benefits are derived from being in the current location would effectively remain the same in the new location.

c. The effect on the business of relocating twice could be potentially significant as there would be costs and expenditure associated with the move including but not limited to removal expenses, legal and surveyor fees, taxes, costs of securing and adapting new premises, temporary loss of profits during the period of the move, and diminution of goodwill following the move (reflected in reduced profits).

d. However, in accordance with the *Thames Tideway Tunnel compensation programme* (included within Schedule 2 of the *Statement of Reasons*, which accompanies the application), compensation would be available. Given that Thames Water would comply with the provisions of the statutory compensation code, it is assumed for the purposes of this assessment that reasonable costs and expenditure incurred in association with the two moves would be met.

e. Accordingly, it is considered that The President and the businesses on board would be likely to continue operating viably. There may be a very short term effect while the relocation of the vessel was taking place on part time employment provided by the function and event venue business as there may be a short period when no functions or events can take place.

10.5.17 Taking account of the above, it is considered that the magnitude of the impact arising from the relocation of The President to a temporary position and then back to its existing position would be low.

10.5.18 Given the low impact magnitude and the medium sensitivity of the business, the effect of the temporary relocation of The President would be **minor adverse**.

Effect on the users of the specialist sports facility

10.5.19 Access to the specialist sports facility, located to the west of Blackfriars Bridge, would be blocked during construction. The clubs using the facility are understood to be negotiating a renewal short term lease that would enable them to stay until the commencement of the proposed construction works at this site. Prior to construction of the Thames Tideway Tunnel commencing, the member clubs that lease the facility would vacate the specialist sports facility.

10.5.20 The magnitude of the impact is influenced by the following factors:

a. It is understood that the lease is a renewal short term lease of a previously expired lease. It is currently unknown whether the facility could be reinstated once construction works cease. This is likely to depend on negotiations between the clubs and the landlord.

b. Up to seven clubs would vacate the site prior to the commencement of the works.

10.5.21 Taking account of the above, and given that the clubs are on a short term lease, it is considered that the magnitude of the impact would be low.

10.5.22 Given the low magnitude of impact and the medium sensitivity, the effect on the users of the specialist sports facility would be **minor adverse**.

Effect on the amenity of Thames Path users

10.5.23 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 (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 and construction dust effects would be **minor adverse**.

b. No noise and vibration receptors were identified for assessment at the project site in relation to the Thames Path.

c. At the five viewpoints identified on the north side of the River Thames (including from bridges) and within 250m of the site, visual effects would be **major adverse** at one (viewpoint 2.1); **moderate adverse** at another (viewpoint 2.12); and **minor adverse** at the remaining three (viewpoints 2.2, 2.10 and 2.11).

10.5.24 In assessing the overall magnitude of impact, the above findings have been taken into consideration together with the following factors that are relevant to the overall experience of amenity at this site:

a. Given the five year construction programme, the effects noted above would be likely to be experienced over a long 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. Any impact would affect a high number of users although many would be occasional recreational users, including tourists.

c. 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 construction site would be a relatively short period of time and so most users' experience of amenity impacts would be brief. The exception is to this is that visual effects would impact on users from a number of viewpoints around the site, thereby potentially lasting for a longer period as people move through the area along the Thames Path.

10.5.25 Given the above findings and factors, it is considered that the magnitude of amenity impact would be medium.

10.5.26 Given the medium magnitude of impact and the low sensitivity, the effect on the amenity of Thames Path users would be **minor adverse**.

Effect on a business (The President's event and function venue) due to construction activity

10.5.27 If customers are sufficiently deterred from booking functions and events at The President venue due to amenity impacts such as noise, dust or unpleasant views, then the business could suffer deterioration in trade[vii]. For this reason the overall effect on amenity, as it would be experienced by people attending functions at The President, is considered below.

10.5.28 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, Section 9, and Section 11). The following points summarise the residual effect findings of those assessments in relation to The President:

a. Local air quality effects would be **major beneficial** (owing to the new location experiencing lower levels of background air pollution). Construction dust effects would be **minor adverse**.

b. Both noise effects and vibration (human response) effects would be **not significant**.

c. The President was not assessed as a receptor for the purposes of the visual impact assessment.

10.5.29 In assessing the overall magnitude of impact, the above findings have been taken into consideration together with the following factors that are relevant to the way in which the businesses would be affected:

a. Given the five 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 major beneficial over the whole construction period as the assessment is purely based

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[vii] The effect on the offices space within the vessel has not been considered in line with the approach to assessing amenity related effects set out in Volume 2.

on the peak construction year and these beneficial effects may be reduced in other years.

b. Although no viewpoints were identified in relation to the vessel, a moderate adverse effect was identified on recreational receptors at a viewpoint which takes in views of the construction site from the Thames Path. This viewpoint (viewpoint 2.12) is at a position opposite the Inner Temple Gardens, near to where The President is likely to be temporarily relocated. This viewpoint provides a useful proximate reference for views from the deck of the vessel, although it is not a precise substitute. However, similar views of the proposed construction site from inside many of the vessel's event and function rooms would be curtailed or non-existent for patrons. As such, viewpoints from within the vessel, apart from those from its east facing deck, are unlikely to be as severely affected as views from the adjacent Thames Path.

c. Based on the enclosed indoor nature of the business' hospitality rooms and the likelihood that it relies strongly on pre-booked functions and events, it is considered that there is a low risk of there being a decline in bookings at the venue.

10.5.30 Taking account of the above findings and factors, it is considered that the magnitude of impact on the business is likely to be low.

10.5.31 Given a low magnitude of impact and the medium sensitivity of the business, in a worst case scenario it is considered that the effect on The President's event and function venue business due to construction activity would be **minor adverse**.

Effect on a business (conference centre and hotel) due to construction

10.5.32 If organisations were sufficiently deterred from booking conferences and functions, or if guests were sufficiently deterred from staying at the hotel due to amenity impacts such as dust, noise or unpleasant views, then the conference centre and neighbouring hotel business could suffer a deterioration of trade. For this reason the effects on environmental amenity as they would be experienced by visitors to the Mermaid Conference Centre and hotel are relevant and are considered below.

10.5.33 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, Section 9, and Section 11).

10.5.34 The air quality, construction dust, noise and vibration topic assessments found that residual effects arising as a result of construction activity would be **negligible** / **not significant** on the Mermaid Conference Centre and Puddle Dock Mermaid Theatre site hotel. No viewpoint receptors were identified for assessment in relation to the business and/or hotel.

10.5.35 Given these results, it is therefore considered that there would be little likelihood that guests at the venue would be disturbed and therefore, it is considered that the business would be able to continue to operate as it would do otherwise in the base case. On this basis, it is considered that the magnitude of overall amenity impact would be negligible.

10.5.36 Given a negligible magnitude of impact and the medium sensitivity, it is considered that the effect on the business due to construction would be **negligible**.

Effect on the amenity of open space (Inner Temple Garden) users

10.5.37 Assessments have been undertaken to examine the likelihood of significant air quality, construction dust, noise, vibration, and visual effects of the project 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 Inner Temple Gardens:

a. Local air quality effects would be **minor adverse** and construction dust effects would be **negligible**.

b. No noise, vibration or viewpoint receptors were identified for assessment in relation to the gardens.

10.5.38 In assessing the overall magnitude of impact, the above findings have been taken into consideration together with the following factors that are relevant to the way in which the open space users would be affected:

a. Although there would be a five year construction programme at this site, 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. The gardens are only open for a very limited period and this would act to constrain the number of users that could be affected.

10.5.39 Given these results, it is considered that the magnitude of amenity impacts overall would be negligible.

10.5.40 Given the negligible magnitude of impact and the medium sensitivity of users, the effect on the amenity of open space users would be **negligible**.

Effect on the amenity of residents

10.5.41 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, Section 9, and Section 11).

10.5.42 Of the representative residential receptors identified on the north bank of the River Thames and within 250m of the site, local air quality, construction dust, noise and vibration (human response) residual effects would be **negligible** / **not significant** respectively. In regard to road-based construction traffic, the noise assessment states that the change in noise level due to construction traffic is considered to be **not significant**. Further, no residential visual receptors which are both on the north side of the River Thames and within 250m of the site were identified for assessment.

10.5.43 Given these results, it is therefore considered that nearby residents would be unlikely to be disturbed by the construction activity at the site. On this basis, it is considered that the magnitude of impact would be negligible.

10.5.44 Given the negligible magnitude of impact and medium sensitivity, the effect on the amenity of residents would be **negligible**.

10.6 Operational effects assessment

Permanent gain of public amenity space

10.6.1 The extension of the river wall out into the foreshore would result in the permanent provision of an increased area of pleasantly landscaped and functional public amenity space measuring approximately 0.4ha in size.

10.6.2 The magnitude of the impact is influenced by the following factors:

a. The new amenity space would offer an increased area of functional, landscaped space along this section of the Thames Path, create additional opportunities for passive recreation and provide an increased level of amenity along this section of the Thames Path (except on rare occasions during maintenance work).

b. The effect would be permanent.

c. The new space would be the equivalent of a full size pocket park under the Mayor's Public Open Space Hierarchy and it would therefore represent a significant addition to the provision of social infrastructure in the local area. Such size spaces typically serve a catchment area of up to 400m for local residents and employees. However, given its position on the Thames Path in central London, it is likely to draw usage from a wider catchment area.

d. Given the high numbers of people that use this section of the Thames Path at most times of the day and the relative lack of alternative spaces nearby, the new space is likely to benefit a high number of users, including local residents, local workers, and both domestic and international tourists.

10.6.3 Taking account of the above, in particular the benefits that a permanent new amenity space would bring to users of the space, it is considered that the magnitude of impact would be medium.

10.6.4 Given the medium magnitude of impact and the medium sensitivity, it is considered that the effect of the permanent gain of public amenity space would be **moderate beneficial**.

10.7 Cumulative effects assessment

Construction

10.7.1 As described in Section 10.3 no developments within the amenity effect assessment area would be under construction at the same time as the Thames Tideway Tunnel project at this site. Therefore, no cumulative effects are likely to arise.

10.7.2 Therefore, the effects on socio-economics would remain as described in Section 10.5 above.

Operation

10.7.3 As described in Section 10.3, there are no other developments that could have the same type of effect as that considered in Section 10.6 and therefore, no cumulative effects require consideration.

10.7.4 Therefore, the effects on socio-economics would remain as described in Section 10.6.

10.8 Mitigation

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.

Operation

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 Section10.6.

10.9.4 All residual effects are presented in Section 10.10.

10.10 Assessment summary

Vol 18 Table 10.10.1 Socio-economics – summary of construction assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Thames Path	Temporary diversion of a section of the Thames Path	Minor adverse	None	Minor adverse
Blackfriars Millennium Pier – pier owner and service operators	Effect on the pier owner and operator due to relocation of the pier	Minor adverse	None	Minor adverse
Business located at Blackfriars Millennium Pier – Crown River Cruises	Effects of relocation of the business on Blackfriars Millennium Pier – Crown River Cruises	Minor adverse	None	Minor adverse
Business – The President	Relocation of The President	Minor adverse	None	Minor adverse
Users of specialist sports facility	Displacement of specialist sports facility	Minor adverse	None	Minor adverse
Thames Path	Effects on the amenity of Thames Path users	Minor adverse	None	Minor adverse
Business – The President event and function venue	Effects on a business (The President event and function venue business) due to construction activity	Minor adverse	None	Minor adverse
Businesses – conference centre and hotel	Effects on a business (conference centre and hotel) due to construction activity	Negligible	None	Negligible
Open spaces – Inner Temple Garden	Effects on the amenity of Inner Temple Garden users	Negligible	None	Negligible
Residential	Effect on the amenity of residents	Negligible	None	Negligible

Vol 18 Table 10.10.2 Socio-economics – summary of operational assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Future users of the Thames Path and public amenity space	Permanent gain of public amenity space	Moderate beneficial	None	Moderate beneficial

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[8] People1st. *State of the Nation Annual Report Executive Summary* (2011). Available at: http://www.goskills.org/webfiles/Research/State%20Of%20The%20Nation/2011/State_of_the_Nation_2011_Executive_Summary.pdf. Accessed August 2012.

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[10] Greater London Authority. *The London Plan 2011* (2011), page 180.

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.18**

Volume 18 Blackfriars Bridge Foreshore site assessment

Section 11: Townscape and visual

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

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Thames Tideway Tunnel

Environmental Statement

Volume 18: Blackfriars Bridge 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 Blackfriars Bridge Foreshore. The assessment considers effects arising from both the Blackfriars Bridge Foreshore main site and Blackfriars pier site. 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 phase assessment includes effects on townscape character areas, and visual effects during daytime. The assessment also identifies mitigation measures where appropriate.

11.1.3 An assessment of effects arising from lighting during the construction phase is not required because it is judged that there would not be any significant effects (this is further explained in para. 11.3.12).

11.1.4 Each section of the assessment is structured with townscape aspects 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 18 Blackfriars Bridge 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 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 and piled deck using a piling rig

c. clearance of the site in advance of works, including removal of Millennium Pier and stretches of the river wall

d. provision of welfare facilities, assumed to be a maximum of three storeys in height

e. establishment of 2.4m high hoardings around the boundary of the construction site.

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'*(British Standards, 2012)(see *CoCP Part A* Section 11)[2]

b. protection of listed structures, including the river wall (see *CoCP Part A* Section 12)

c. use 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 provision for incorporating suitable art work and viewing windows on public facing sections of hoarding.

Operation

11.2.5 The particular components of importance to this topic include the:

a. design and materials used for the river wall around the new foreshore structure

b. design, layout and materials used in the public realm including the treatment of level changes, seating, railings and lighting (including feature lighting of the ventilation columns)

c. design, siting and materials used for the ventilation column and control kiosks, and the zones within which these above ground structures may be located

d. size, layout and species used for tree planting along Victoria Embankment and on the foreshore structure.

Environmental design measures

11.2.6 Figures illustrating the proposed development during operation are contained in a separate volume (Volume18 Blackfriars Bridge Foreshore Figures). Where photomontages have been prepared to assist the assessment of the 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 (shown on the Proposed landscape plans, see separate volume of figures – Section 1 and described in the *Design Principles* report*,*Vol 1 Appendix B) include the:

a. use of natural stone for the river wall, in keeping with the existing Embankment wall and the use of lions heads on the wall as far as possible

b. use of shadow gaps where appropriate along the elevation of the river wall to reduce the visual bulk of the foreshore structure

c. design and layout of the foreshore structure, which is sympathetic to the geometry and character of the surrounding townscape and would provide additional public open space along the river

d. majority of the electrical and control would be located in the undercroft area. The smaller kiosk required near the shaft would be incorporated into the line of the existing river wall

e. use of high quality screens for the voids below the ramp, in keeping with the architectural and landscape design

f. retention of the majority of the existing river wall visible above ground level and lamp columns along Victoria Embankment

g. use of natural stone for the surfacing of the public realm

h. use of visually unobtrusive hand railings along the river wall of the foreshore structure

i. use of low level lighting for the public realm which is capped and directional to minimise light spill

j. commitment to a high quality design for the ventilation columns

k. planting of semi mature London plane trees along Victoria Embankment to partially filter views of the new foreshore structure

l. reinstatement of the festoon lighting and sturgeon lamp stands along Victoria Embankment as far as possible

m. views towards the listed buildings along Victoria Embankment and St Paul's Cathedral from the river would be retained and respected.

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 City of London Corporation and neighbouring authorities (London Borough (LB) of Southwark, LB of Lambeth 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. The LB of Lambeth (March 2011) have confirmed acceptance of the proposed viewpoints. The Westminster City Council(March 2011) requested an additional viewpoint from the northern end of Waterloo Bridge, which has been included in the visual assessment. English Heritage (May 2011) have confirmed acceptance of the proposed viewpoints. The City of London Corporation and LB of Southwark have not commented on 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, particularly with regard the shape of the proposed foreshore structure. 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 removing one viewpoint altogether (due to it being inaccessible) and removing one viewpoint from the operational assessment. The City of London Corporation (July 2012) requested that:

a. due regard was made to the St Paul's heights policy. The text in this volume has been amended to ensure this is made clear.

b. figures were amended to include the full extents of London View Management Framework viewing corridors. The figures have been amended to this effect.

c. further viewpoints were considered in the visual assessment from other River Prospects in the assessment area, with further photomontages prepared from each. On the basis that the proposed development would be barely perceptible from these locations during both construction and operation, these additional viewpoints have not been included in the assessment.

d. further photomontages were prepared from River Prospects already included in the assessment. Additional verifiable photomontages have been prepared as requested.

11.3.5 The LB of Lambeth (July 2012) confirmed acceptance of the proposed changes. The LB of Southwark, Westminster City Council and English Heritage have not commented on the proposed changes.

11.3.6 The City of London Corporation also requested that an assessment of the effects of operational phase lighting at night time was undertaken for visual receptors in the assessment area (May 2012). This has been undertaken and is reported in Section 11.6.

11.3.7 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

11.3.8 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 surveys of townscape character areas (August 2011 and August 2011)

c. Winter photographic surveys of the view from each visual assessment viewpoint (November 2011, November 2011, January 2012, January 2012 and January 2012)

d. Summer photographic surveys of the view from each visual assessment viewpoint considered in the operational assessment (August 2011 and August 2011 and June 2012)

e. Night time survey of the view from each visual assessment viewpoint considered in the operational assessment (June 2012)

f. Daytime verifiable photography (March 2011), night time verifiable photography (March 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).

11.3.9 With specific reference to the Blackfriars Bridge 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 London View Management Framework (Mayor of London, 2012)[3]

b. The Core Strategy for the City of London[4], including the St Paul's heights policy and the neighbouring LB of Southwark[5], LB of Lambeth[6] and Westminster City Council[7]

c. Whitefriars[8] and Temples[9] Conservation Area Character Summaries, produced by the City of London Corporation

d. Temples Conservation Area: Management Strategy, produced by the City of London Corporation[10]

e. South Bank Conservation Area Statement[11], produced by the LB of Lambeth

f. Savoy and Strand Conservation Area General Information Leaflets, produced by the Westminster City Council[12].

Construction

11.3.10 The assessment methodology for the construction phase follows that described in Vol 2. Site specific variations are described below.

11.3.11 With reference to the Blackfriars Bridge 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. 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 short connection tunnel, involving the import of materials by road.

11.3.12 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 during major concrete pours

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.

11.3.13 The assessment area, defined using the methodology provided in Vol 2, is indicated in Vol 18 Figure 11.4.6 for townscape and Vol 18 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 upstream of the site where visibility is in reality obscured by Waterloo Bridge, and those locations downstream of the site where the visibility is in reality obscured by Southwark Bridge. The scale of the visual assessment area has been set by the maximum extent of the construction phase ZTV, except in those locations upstream of the site where visibility is in reality obscured by Waterloo Bridge, and those locations downstream of the site where the visibility is in reality obscured by Southwark Bridge. All visual assessment viewpoints are located within the ZTV.

11.3.14 The construction assessment area for this site intersects with the assessment area for the proposed Thames Tideway Tunnel project site at Victoria Embankment Foreshore; therefore likely significant effects on receptors arising from construction at both sites are included in this assessment.

11.3.15 For the construction base case for the assessment of effects arising from the proposed development at the Blackfriars Bridge 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. Puddle Dock Mermaid Theatre seven storey hotel to the east of the site

b. 1-16 Blackfriars Road mixed use development, including a 50 storey tower, and two buildings of 6 and 4 storeys, approximately 260m to the south of the site

c. Bankside mixed use development to the south of the site on the opposite side of the river

d. Tate Modern art gallery extension on the southern bank of the river, downstream of Blackfriars railway bridge

e. 20 Blackfriars Road mixed use development including two towers of 23 and 42 storeys, approximately 500m to the south of the site

f. Wedge House 11 storey commercial development, approximately 500m to the south of the site

g. London Eye Pier extension, approximately 930m southwest of the site

h. Elizabeth House commercial, retail and residential development, comprising three buildings between 11 and 29 storeys high, approximately 820m southwest of the site

i. Mixed use development on land bounded by Upper Ground and Doon Street, including a 43 storey tower, approximately 550m southwest of the site

j. Commercial and retail 20 storey tower at 231-241 Blackfriars Road, approximately 400m south of the site.

11.3.16 None of the other schemes outlined in the site development schedule (Vol 18 Appendix N) are considered relevant to the construction base case, either by virtue of their limited scale or location outside the construction assessment area.

11.3.17 As detailed in the site development schedule (Vol 18 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 Blackfriars Bridge Foreshore in the construction phase.

11.3.18 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

11.3.19 The assessment methodology for the operational phase follows that described in Vol 2. Any site specific variations are described below.

11.3.20 Three daytime verifiable photomontages have been prepared for this site to assist the assessment of operational visual effects during the day. These are shown in Vol 18 Figure 11.6.1, Vol 18 Figure 11.6.3 and Vol 18 Figure 11.6.5 (see separate volume of figures). Two night time verifiable photomontages have been prepared for this site to assist the assessment of operational visual effects during the night. These are shown in Vol 18 Figure 11.6.2 and Vol 18 Figure 11.6.4 (see separate volume of figures).

11.3.21 The operational phase assessment has been undertaken for Year 1 of operation and Year 15 of operation.

11.3.22 The assessment area, defined using the methodology provided in Volume 2, is indicated in Vol 18 Figure 11.4.6 for townscape and Vol 18 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 upstream of the site where visibility is in reality obscured by Waterloo Bridge, and those locations downstream of the site where the visibility is in reality obscured by Southwark Bridge. The scale of the visual assessment area has been set by the maximum extent of the operational phase ZTV, except in those locations upstream of the site where visibility is in reality obscured by Waterloo Bridge, and those locations downstream of the site where the visibility is in reality obscured by Southwark Bridge. All visual assessment viewpoints are located within the ZTV.

11.3.23 The operational assessment area for this site intersects with the assessment area for the proposed Thames Tideway Tunnel project site at Victoria Embankment Foreshore, therefore likely significant effects on receptors arising from operation at both sites are assessed in this assessment.

11.3.24 For the purposes of the operational assessments, it is assumed there would be no further substantial changes in the townscape and visual baseline, beyond those described in para. 11.3.15, between 2012 and Year 1 and Year 15 of operation.

11.3.25 As detailed in the site development schedule (Vol 18 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 Blackfriars Bridge Foreshore in the operational phase.

11.3.26 As with construction (para. 11.3.18), 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

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

Assumptions

11.3.28 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 phase 2 (shaft construction) construction 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 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).

11.3.29 For the purposes of the operational phase assessment, it is assumed that the above ground structures are in the location shown on the Proposed 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 figures – Section 1).

Limitations

11.3.30 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 18 Figure 11.4.1 (see separate volume of figures).

Topography

11.4.3 The assessment area is located on a relatively flat plateau along Victoria Embankment. To the east, the Thames Path drops to pass under Blackfriars Bridge, while the road rises on a ramp to connect with it. To the north, the ground rises away from the river.

Land use

11.4.4 In the assessment area, the north bank of the river is predominantly characterised by commercial and administrative uses, with some leisure and retail further from the river. On the southern bank of the river, land use is dominated by a mix of cultural, leisure and tourism related uses, including the Tate Modern art gallery, Shakespeare's Globe theatre, the National Theatre and Royal Festival Hall. Some high rise office and residential units are located directly opposite the site, including the Oxo Tower, with smaller residential properties further away from the river.

Development patterns and scale

11.4.5 Vol 18 Figure 11.4.2 (see separate volume of figures) illustrates the pattern and scale of development and building heights within the assessment area.

11.4.6 Within the assessment area, the north bank of the river is characterised by dense blocks of buildings with large footprints and heights of up to approximately 40m. Buildings are typically orientated towards the river and streets are narrow and laid out in a grid formation parallel with the river. West of Blackfriars Bridge, Victoria Embankment provides a wide vehicular and pedestrian route alongside the river. East of Blackfriars Bridge, buildings have typically been designed to be close to the river, and this has resulted in the Thames Path being narrow in nature and in places has been diverted inland.

Vegetation patterns and extents

11.4.7 Vol 18 Figure 11.4.3 (see separate volume of figures) illustrates the pattern and extent of vegetation, including tree cover, within the assessment area.

11.4.8 Street trees are uncommon within the assessment area to the north and south of the river. In contrast to the west of the site, Victoria Embankment is characterised by a substantial avenue of trees, which runs as far as Temple Gardens, approximately 300m northwest of the site. Smaller trees are present along the southern bank, including closely spaced blocks of silver birch trees at the entrance to the Tate Modern art gallery.

11.4.9 There are several public open spaces within the assessment area and typically they are characterised by open grassland and informally scattered trees. Most of the vegetation within the assessment area on both sides of the river is contained within private and semi-private spaces, particularly within housing estates, internal courtyards and private rear gardens to the south of the river.

11.4.10 The majority of mature trees within the City of London are protected by Tree Preservation Orders, and trees on both sides of the river are protected by conservation area status.

Open space distribution and type

11.4.11 Vol 18 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.

11.4.12 The majority of open spaces within the assessment area are private or semi-private, associated with residential or commercial premises. Public open spaces are limited to a series of gardens and pedestrian routes close to the river and a series of spaces around St Paul's Cathedral. These are described in more detail in Vol 18 Table 11.4.1 below.

11.4.13 The City of London Corporation has designated the majority of public and private open spaces as 'Soft Open Space' in the Unitary Development Plan (UDP). Similarly, the LB of Southwark has designated a number of spaces as 'Borough Open Land', and the LB of Lambeth has designated spaces as either 'Parks' or 'Other public open spaces'. Jubilee Gardens to the southwest of the site is designated as Metropolitan Open Land (MOL).

Vol 18 Table 11.4.1 Townscape – open space type and distribution

Open space	Distance from site	Character summary
Victoria Embankment Gardens	450m west (north of river)	Formally designed public gardens with well maintained vegetation, including formal grass areas, trees, shrubs and seasonal flower beds. The gardens also contain several notable statues and landmarks. Designated as Soft Open Space in the City of Westminster UDP.
Temple Gardens	300m northwest (north of river)	Private gardens with some public access, characterised by wide open lawns, informal trees and herbaceous borders. Designated as Soft Open Space in the City of London UDP.
Jubilee Gardens	1km southwest (south of river)	Wide open grassed public space with sparsely scattered trees and feature planted beds, dominated by the London Eye. Designated as MOL and as a Park in the LB of Lambeth's UDP.
South Bank	Closest	Predominantly paved linear pedestrian corridor

Open space	Distance from site	Character summary
	point, 200m south (south of river)	on the South Bank of the river, with double avenues of small trees. Characterised by large numbers of visitors associated with leisure and retail uses along the river frontage. Partially designated as an 'Other public open space' in the LB of Lambeth UDP.
Bernie Spain Gardens	300m southwest (south of river)	Public gardens characterised by areas of lawn and informal tree and shrub planting. Designated as a Park in the LB of Lambeth UDP.
Tate Modern	350m southeast (south of river)	Public open space situated in front of Tate Modern art gallery, characterised by formally laid out blocks of trees, paved areas and grass, located around the approach to the Millennium Bridge.

Transport routes

11.4.14 Vol 18 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.

11.4.15 The site is located immediately adjacent to Victoria Embankment and Blackfriars Bridge, and is characterised by high levels of traffic. Other strategic, heavily trafficked routes in the assessment area include Waterloo Bridge to the west, the A3200 to the south and the A300 to the east. The majority of other streets are fairly narrow and characterised by varied levels of both vehicular and pedestrian traffic.

11.4.16 The Thames Path runs along both banks of the river, although the route is much wider and dedicated to pedestrians on the southern bank.

11.4.17 The townscape south of the river is heavily dissected by rail corridors connecting Blackfriars railway station with south London, and Waterloo East railway station with southeast London.

Site character assessment

Blackfriars Bridge Foreshore main site

11.4.18 The Blackfriars Bridge Foreshore site is located within Whitefriars Conservation Area in the City of London, and is immediately west and underneath the Grade II listed Blackfriars Bridge. The site is located partially on a stretch of pavement along Victoria Embankment and partially within the River Thames. The Blackfriars Millennium Pier is located within the site boundary.

11.4.19 Within the Blackfriars Bridge Foreshore site boundary, the western stretch of river wall is Grade II listed, while the eastern stretch is not listed and was rebuilt during the construction of the approach ramp to Blackfriars Bridge (1960s). Lamp standards across the frontage are also Grade II listed. At the western end of the main site, trees in Victoria Embankment are protected by TPOs. The character of the Blackfriars Bridge Foreshore site is illustrated by Vol 18 Plate 11.4.1 and the components of the site are described in more detail in Vol 18 Table 11.4.2.

Vol 18 Plate 11.4.1 The character of the site

Date taken: 4 October 2010. 18mm lens.

Vol 18 Table 11.4.2 Townscape – site components

ID	Component	Description	Condition
01	Blackfriars Millennium Pier	Modern floating river bus pier, constructed in 2000, extending approximately 15m into the river. To the eastern end of the pier there is a small two storey former pump house located in the river.	Good condition
02	Grade II listed river wall	Granite clad river wall constructed by Bazalgette between 1865 and 1870. The wall has regularly spaced stanchions and sits at flood defence level, approximately 1m higher than the pavement level.	Good condition
03	Reconstructed river wall	At the point when the vehicular ramp rises from Victoria Embankment to Blackfriars Bridge, the river wall was reconstructed to the same style as the original listed wall. The wall sits higher than the flood defence level.	Good condition

ID	Component	Description	Condition
04	Grade II listed lamp standards (sturgeon lamp columns)	16 ornamental cast iron lamp standards positioned on the regularly spaced stanchions in the river wall.	Good condition
05	Mature trees	Mature London plane trees, protected by TPOs forming the end of a long avenue along Victoria Embankment.	Good condition
06	Thames Path	Sandstone paved pavement alongside the river wall and Victoria Embankment road.	Relatively poor condition
07	President	This recreational ship is moored within the site, beyond the pier to the west.	Good condition

11.4.20 The foreshore is generally not exposed at low tide in the majority of the site boundary area.

11.4.21 The site is located within two protected views in the London View Management Framework (LVMF). This identifies protected linear viewing corridors from Westminster Pier (8A.1) and King Henry VIII's Mound, Richmond (9A.1) to St Paul's Cathedral.

11.4.22 A baseline description of Whitefriars 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 good, with the majority of components maintained to a high standard.

11.4.24 The location of the site, close to the interchange of Victoria Embankment and Blackfriars Bridge, means it is dominated by heavy traffic and therefore has a limited level of tranquillity. The river is also heavily used, further reducing levels of tranquillity.

11.4.25 The site is located within a nationally important historical and cultural stretch of the River Thames, experienced by large numbers of people and located within two protected viewing corridors towards St Paul's Cathedral.

11.4.26 Because of the national importance of the site's character and its good condition the Blackfriars Bridge Foreshore site has a high sensitivity to change.

Blackfriars Pier site

11.4.27 Works associated with the proposed relocation of the Millennium Pier would be confined to a separate working area east of the Grade II Blackfriars Bridge and Blackfriars railway bridge. This Blackfriars Pier site is located partially on a stretch of the Thames Path and partially within the River Thames, with no townscape components of note.

11.4.28 The foreshore is generally not exposed at low tide in most of the site boundary area.

11.4.29 The condition of the townscape within the site is good, with limited potential for enhancement.

11.4.30 The site's location, close to the White Lion Hill Road and Blackfriars railway bridge, means it has a limited level of tranquillity. The river is also heavily used, further reducing levels of tranquillity.

11.4.31 The site is located within a nationally important historical and cultural stretch of the River Thames, experienced by large numbers of people.

11.4.32 The national importance of the site and its good condition, means the Blackfriars Pier site has a high sensitivity to change.

Townscape character assessment

11.4.33 The townscape character areas surrounding the site are identified in Vol 18 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 – Central London Reach TCA

11.4.34 This reach of the River Thames extends from Waterloo Bridge in the west towards to Southwark Bridge in the east. The reach is characterised by dense commercial and tourist related development along both banks, much of which reflects the strong heritage of central London. This stretch of the river is crossed by Waterloo Bridge (road and pedestrian), Blackfriars Bridge (road and pedestrian), Blackfriars Bridge (rail), the Millennium Bridge (pedestrian) and Southwark Bridge (road and pedestrian). The character of this area is illustrated by Vol 18 Plate 11.4.2.

Vol 18 Plate 11.4.2 River Thames – Central London Reach TCA

Date taken: 09 August 2011. 28mm lens.

11.4.35 The river is characterised by numerous jetties and permanent moorings beyond the historic stone river wall. The north bank has little or no foreshore, while in contrast the southern bank has a relatively wide area of foreshore exposed at low tide. The overall character is urban, with little planting along the banks of the river. The exception is the avenue of London plane trees along part of Victoria Embankment, west of the site, illustrated by Vol 18 Plate 11.4.2 above.

11.4.36 The jetties, river wall and bridges are well maintained. The overall townscape condition is good.

11.4.37 Tranquillity within the area is limited by the intensity of activity on the river, which is used by commercial and industrial boats, river taxis and pleasure craft, and further reduced by heavy traffic along Victoria Embankment.

11.4.38 This reach is an internationally valued stretch of the river, experienced by large numbers of people, including a high percentage of tourists. The main attractions are (from west to east) Somerset House, the National Theatre, the Oxo Tower, St Paul's Cathedral and the Tate Modern art gallery which form the key components of the setting.

11.4.39 Because of the international value of the townscape and its good condition, this character area has a high sensitivity to change.

River Thames – Victoria Embankment Gardens and Jubilee Gardens Reach TCA

11.4.40 This reach of the River Thames extends from Westminster Bridge in the west to Waterloo Bridge in the east, both of which lie to the west of the site. The reach is characterised by dense commercial, administrative and tourism related development along both banks, reflecting the strong heritage of central London. The area features the large open spaces of

Victoria Embankment Gardens and Jubilee Gardens. The avenue of London plane trees on Victoria Embankment forms a substantial element of the setting along the northern bank. The setting along the southern bank is dominated by the London Eye, in addition to the County Hall. The Houses of Parliament (a World Heritage Site) forms part of the wider setting of this area. This stretch of the river is crossed by Westminster Bridge (road and pedestrian), Hungerford Bridge (rail) and the attached Golden Jubilee footbridges, and Waterloo Bridge (road and pedestrian). The character of this area is illustrated by Vol 18 Plate 11.4.3.

Vol 18 Plate 11.4.3 River Thames – Victoria Embankment Gardens and Jubilee Gardens Reach TCA

Date taken: 12 August 2011. 18mm lens.

11.4.41 The river is characterised by numerous jetties and permanent moorings which extend from the historic stone river wall. The north bank of the river has little or no foreshore, while the southern bank has a relatively narrow stretch of foreshore exposed at low tide. The overall character is urban. Formal tree planting along Victoria Embankment, and also within Victoria Embankment Gardens and Jubilee Gardens form prominent elements on the edges of the character area.

11.4.42 The jetties, river wall and bridges are well maintained. The overall townscape condition is good.

11.4.43 Tranquillity within the area is limited by the daily density of activity on the river, which is used by commercial and industrial boats, river taxis and pleasure craft.

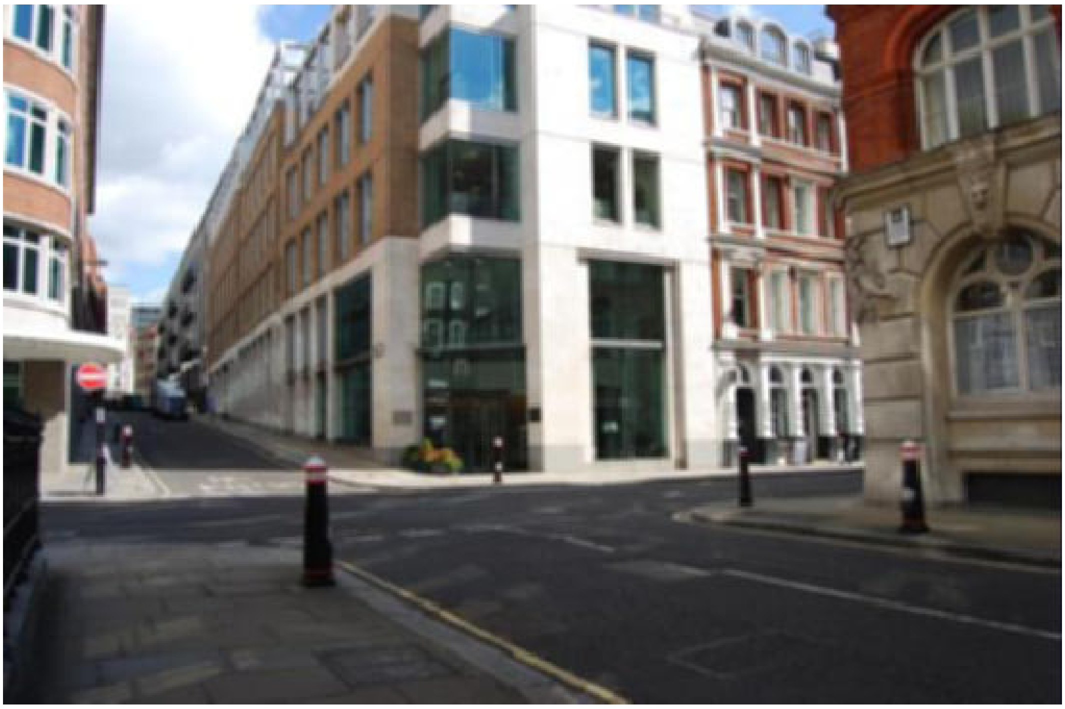
11.4.44 This reach is an internationally valued stretch of the river, experienced by large numbers of people, with a high percentage of tourists visiting attractions such as the London Eye and the Houses of Parliament (in the neighbouring character reach of the river), which form key components of the setting.

11.4.45 Because of the international value of the townscape and its good condition, this character area has a high sensitivity to change.

Whitefriars Conservation Area TCA

11.4.46 This area comprises Whitefriars Conservation Area (designated by the City of London Corporation) and an area, north of the conservation area, which is not designated, but is of similar character. The area features large scale Victorian and Edwardian commercial and administrative premises set out on a formal grid pattern. The majority of buildings are four to five storeys in height, and the river frontage is framed by a strong frontage of five to six storey buildings. The character area is bordered to the east and south by busy roads. The river forms a key part of the setting of this area, although existing structures along the Thames Path and on the approach to Blackfriars Bridge detract from the immediate riverside setting. The character of this area is illustrated by Vol 18 Plate 11.4.4.

Vol 18 Plate 11.4.4 Whitefriars Conservation Area TCA



Date taken: 12 August 2011. 18mm lens.

11.4.47 A baseline description of Whitefriars Conservation Area as a heritage asset is provided in Section 7.4 of this volume.

11.4.48 The buildings and public realm within the area are well maintained. The overall townscape condition is good.

11.4.49 Tranquillity within the area is limited by the commercial land use, presence of high levels of vehicular traffic and lack of street trees or other vegetation.

11.4.50 The character area is located within a nationally important historical and cultural stretch of the River Thames, which is experienced by large numbers of people. In addition a protected viewing corridor (towards St Paul's Cathedral) traverses this character area.

11.4.51 This character area is of national value and the townscape is in good condition which gives it a high sensitivity to change.

City of London Mixed Use TCA

11.4.52 This character area includes Bow Lane Conservation Area (designated by the City of London Corporation), alongside the area surrounding the conservation area, which is not designated but is similar in character. The area comprises a number of large scale buildings up to seven storeys high, tightly spaced along narrow streets with little open space. Public realm within the area is typically characterised by hard surfaces with minimal vegetation. The mix of building styles forms a relatively incoherent river frontage, with the majority of buildings located immediately adjacent to a narrow river walkway. The Millennium Bridge provides a strong axis that cuts through the character area, leading to St Paul's Cathedral. The setting of this character area is dominated by the river and St Paul's Cathedral. The character of this area is illustrated by Vol 18 Plate 11.4.5.

Vol 18 Plate 11.4.5 City of London Mixed Use TCA

Date taken: 9 August 2011. 18mm lens.

11.4.53 The buildings and public realm within the area are well maintained. The overall townscape condition is good.

11.4.54 Tranquillity within the area is limited by high levels of vehicular and pedestrian traffic, a lack of street trees and the commercial land uses.

11.4.55 The townscape of the character area is valued at the borough level, by virtue of the conservation area designation.

11.4.56 Because of the borough value of the townscape and its good condition, this area has a high sensitivity to change.

Tate Modern TCA

11.4.57 This area comprises Bankside and Bear Gardens Conservation Areas, including the Tate Modern art gallery and Shakespeare's Globe theatre. The area is characterised by cultural, leisure and tourism related uses along the wide pedestrian frontage of the River Thames. The distinctive form of the Millennium Bridge connects this area to the north of the river and St Paul's Cathedral. Tate Modern art gallery is a Grade II listed building. The river forms the key element of the setting of this area. The character of this area is illustrated by Vol 18 Plate 11.4.6.

Vol 18 Plate 11.4.6 Tate Modern TCA

Date taken: 9 August 2011. 18mm lens.

11.4.58 The buildings and public realm within the area are well maintained. The overall townscape condition is good.

11.4.59 Tranquillity within the area is limited by high levels of pedestrian activity, although this is partially moderated by the presence of green open spaces and numerous street trees.

11.4.60 The character of this area, dominated by the Tate Modern art gallery (a major London landmark) is nationally valued and is experienced by large numbers of people including a high percentage of tourists.

11.4.61 Given the national value of the townscape and its good condition this area has a high sensitivity to change.

Southwark Mixed Use TCA

11.4.62 This area is characterised by mixed use developments including commercial premises interspersed with residential properties. The townscape is dissected by several transport corridors; Blackfriars Road, Southwark Street and the railway connecting Blackfriars railway station with south London. Buildings typically range in height from five to 14 storeys, with newly built office blocks set amongst the smaller grain residential areas. The river frontage features a mix of commercial and residential blocks, set behind the wide pedestrian-only Jubilee Walkway that follows the river. The Oxo Tower and Sea Containers House provide two notable landmarks within the character area that lie directly opposite the site. The area is undergoing extensive regeneration. Landward of the buildings fronting onto the river, the pattern of development is inward looking with a tightly defined setting. The character of this area is illustrated by Vol 18 Plate 11.4.7.

Vol 18 Plate 11.4.7 Southwark Mixed Use TCA

Date taken: 9 August 2011. 18mm lens.

11.4.63 The buildings and public realm within the area are well maintained. The overall townscape condition is good.

11.4.64 Tranquillity within the area is limited by the lack of open spaces and vegetation, and high levels of pedestrian and vehicular activity.

11.4.65 The majority of the area has fairly limited townscape value, although the townscape of the river frontage is valued at the regional scale by virtue of the landmarks that provide the backdrop to the River Thames.

11.4.66 Therefore, despite the enclosed nature of the built environment, its regional value and the good condition means this area has a high sensitivity to change.

South Bank Conservation Area TCA

11.4.67 This area predominantly comprises the South Bank Conservation Area. The area is characterised by large public realm areas along the river front, including Jubilee Gardens, which is designated as MOL. The area is dominated by cultural, leisure and tourism related land uses, including County Hall (Grade II* listed), Royal Festival Hall (Grade I listed) and the National Theatre (Grade II* listed). Building footprints are typically large, and there are a number of tall buildings, including the Shell Building, (regarded as an important element of London's skyline), set behind the London Eye. The townscape is dissected by several transport corridors; Waterloo Bridge, Stamford Street, York Road, and the railway line connecting Waterloo East with Charing Cross on the opposite side of the river via the Hungerford Bridge. Further from the river, there are some residential blocks within the character area. Developments are typically orientated towards the river, and heavily influenced by its character on the northern bank. The character of this area is illustrated by Vol 18 Plate 11.4.8.

Vol 18 Plate 11.4.8 South Bank Conservation Area TCA

Date taken: 9 August 2011. 18mm lens.

11.4.68 A baseline description of South Bank Conservation Area as a heritage asset is provided in Section 7.4 of this volume.

11.4.69 The buildings and public realm within the area are well maintained. The overall townscape condition is good.

11.4.70 Tranquillity within the area is limited by the high levels of pedestrian and vehicular activity, the level of activity on the river and the frequency of trains passing through the area.

11.4.71 The character of this area which is dominated by landmark London buildings is internationally valued, experienced by large numbers of people including a high percentage of tourists.

11.4.72 The area has a high sensitivity to change due to the international value of the townscape and its good condition.

Victoria Embankment Administrative TCA

11.4.73 This area is dominated by administrative and institutional uses present along Victoria Embankment. This character area comprises Savoy Conservation Area and Strand Conservation Area. The buildings in the area are characterised by a mix of building styles and periods, including buildings dating from the early 19th century, late Victorian, Edwardian and early 20th century periods. Along Kingsway and Aldwych buildings are typically around seven storeys high. Buildings fronting onto the Strand are lower and typically between four and six storeys high. The river forms the key element of the setting of this area. The character of this area is illustrated by Vol 18 Plate 11.4.9.

Vol 18 Plate 11.4.9 Victoria Embankment Administrative TCA

Date taken: 12 August 2011. 18mm lens.

11.4.74 The area is further characterised by the level change from the Strand to the river, created in part by the construction of Victoria Embankment. The area is dissected east-west by transport corridors; The Strand and Victoria Embankment are both heavily trafficked routes. These main vehicular and pedestrian routes through the area are characterised by mature tree planting, most notably the avenue of plane trees along Victoria Embankment. Somerset House (Grade I listed) and the Royal Courts of Justice (Grade I listed) are key components of the area's character.

11.4.75 The buildings and public realm within the area are well maintained. The overall townscape condition is good.

11.4.76 Tranquillity within the area is limited by the high levels of pedestrian and vehicular activity and the level of activity on the river.

11.4.77 The character area is located within a nationally important historical and cultural stretch of the River Thames, experienced by large numbers of people including a high percentage of tourists.

11.4.78 Because of the national value of the townscape and its good condition, the area has a high sensitivity to change.

Temples Conservation Area TCA

11.4.79 This area comprises Temples Conservation Area (designated by City of London Corporation) and is dominated by administrative and commercial uses. The area is characterised by the Inner and Middle Temple gardens (Grade II listed), which are enclosed to the north, east and west by large Victorian buildings, and bordered by Victoria Embankment and the River Thames to the south. Temple Gardens are the largest private green space in the City and provide a rich setting to the surrounding buildings. Victoria Embankment in this location is characterised by the avenue of mature London plane trees, which continue further to the west of the character area. The majority of the public realm is characterised by high quality paving. The river forms a key part of the setting of this character area. The character of this area is illustrated by Vol 18 Plate 11.4.10.

Vol 18 Plate 11.4.10 Temples Conservation Area TCA

Date taken: 9 August 2011. 18mm lens.

11.4.80 A baseline description of Temples Conservation Area as a heritage asset is provided in Section 7.4 of this volume.

11.4.81 The buildings and public realm within the area are well maintained. The overall townscape condition is good.

11.4.82 Although Temple Gardens are relatively tranquil, the overall tranquillity of the area is limited by the high levels of pedestrian and vehicular activity and the level of activity on the river.

11.4.83 The character area is located within a nationally important historical and cultural stretch of the River Thames, experienced by large numbers of people. The area is nationally valued as part of the wider character of the River Thames and London.

11.4.84 Because of the national value of the townscape and its good condition, the area has a high sensitivity to change.

Visual baseline

11.4.85 Vol 18 Figure 11.4.7 (see separate volume of figures) indicates the location of viewpoints referenced below, including the LVMF Linear Views that fall within the assessment area. All LVMF viewing corridors, residential and recreational receptors have a high sensitivity to change, and employment receptors have a low 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.

London View Management Framework linear views

Linear View 8A.1 – Westminster Pier to St Paul's Cathedral

11.4.86 This LVMF Linear View passes through the eastern half of the site and has a high sensitivity to change.

Vol 18 Plate 11.4.11 Linear View 8A.1: winter view

Date taken: 27 January 2012. 18mm lens.

11.4.87 The distant view (illustrated in Vol 18 Plate 11.4.11) towards St Paul's Cathedral is glimpsed between the London Eye and the Royal Festival Hall. The site is located below the frame of view, screened by intervening low height buildings and structures.

Linear View 9A.1 – King Henry VIII's Mound, Richmond to St Paul's Cathedral

11.4.88 This LVMF Linear View passes through the site and has a high sensitivity to change.

Vol 18 Plate 11.4.12 Linear View 9A.1: winter view

Date taken: 21 February 2012. 35mm lens.

11.4.89 The far distant view (illustrated in Vol 18 Plate 11.4.12) towards St Paul's Cathedral is framed by an avenue of trees in Richmond Park. The site is located below the frame of view, screened by intervening low height buildings and structures.

Residential

11.4.90 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 north from residences on the opposite river bank

11.4.91 This viewpoint is representative of the typical view from residential properties adjacent to the Thames Path on the southern bank of the River Thames.

Vol 18 Plate 11.4.13 Viewpoint 1.1: winter view

Date taken: 29 November 2011. 18mm lens.

11.4.92 The view (illustrated in Vol 18 Plate 11.4.13) is a wide panorama over the river, dominated by the historic Victorian and Edwardian building facades along the river frontage, the avenue of London plane trees along Victoria Embankment in the left of the image and Blackfriars Bridge to the right. Blackfriars Millennium Pier forms a key component in the view towards the site. Otherwise, views of the site are unobstructed, particularly from upper storeys. While the image illustrates cranes on Blackfriars railway bridge, this work has since been completed.

Vol 18 Plate 11.4.14 Viewpoint 1.1: summer view

Date taken: 9 August 2011. 18mm lens.

11.4.93 In summer, the view towards the site (illustrated in Vol 18 Plate 11.4.14) is largely unchanged.

11.4.94 At night, the view is dominated by decorative lighting on the facades of the buildings adjacent to the site, in addition to street lighting and light spill from vehicles along Victoria Embankment. However, the unlit expanse of river forms the key component of the foreground view at night.

Viewpoint 1.2: View northwest and north from residences along Hopton Street on the opposite river bank

11.4.95 This viewpoint is representative of the view from residential properties between Hopton Street and the South Bank Jubilee Walkway.

Vol 18 Plate 11.4.15 Viewpoint 1.2: winter view towards the Blackfriars Bridge Foreshore main site (northwest)

Date taken: 29 November 2011. 18mm lens.

11.4.96 The view northwest towards the main site (illustrated in Vol 18 Plate 11.4.15) is dominated by the Blackfriars rail corridor and Blackfriars Bridge to the west and a wide open panorama over the River Thames to the east. The background of the view is characterised by commercial buildings on the north bank of the river. Views towards the site are largely obstructed by the Blackfriars Bridge and Blackfriars railway bridge. The existing river wall and Blackfriars Millennium Pier at the site can be glimpsed through the bridge arches. While the image illustrates cranes on Blackfriars railway bridge, this work has since been completed.

11.4.97 During summer, the view towards the main site is unchanged due to the lack of vegetation within the panorama. Therefore, no photo is included during summer.

Vol 18 Plate 11.4.16 Viewpoint 1.2: winter view towards the Blackfriars Pier site (north)

Date taken: 29 November 2011. 18mm lens.

11.4.98 The view north towards the Blackfriars Pier site (illustrated in Vol 18 Plate 11.4.16) is characterised by the commercial buildings along the river frontage of the north bank, and St Paul's Cathedral in the background of the view. Views of the Blackfriars Pier site are unobstructed from this location. While the image illustrates cranes on Blackfriars railway bridge, this work has since been completed.

11.4.99 During summer, the view towards the Blackfriars Pier site is unchanged due to the lack of vegetation within the panorama. Therefore, no photo is included during summer.

Recreational

11.4.100 Recreational receptors (apart from those engaged in active sports) generally 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 northwest from Blackfriars Bridge (LVMF River Prospect)

11.4.101 This viewpoint is recorded as a River Prospect in the LVMF (Blackfriars Bridge viewing location 14A.1) and is representative of the typical view pedestrians experience while crossing Blackfriars Bridge.

Vol 18 Plate 11.4.17 Viewpoint 2.1: winter view

Date taken: 22 November 2011. 18mm lens.

11.4.102 The view (illustrated in Vol 18 Plate 11.4.17) is linear in nature, focused along Victoria Embankment. The foreground of the view is dominated by Millennium Pier (within the site boundary) and the Victorian and Edwardian building façades that lie directly behind the site. The background of the view is characterised by the sweep of Victoria Embankment with the avenue of London plane trees. Views of the site are unobstructed from this location.

Vol 18 Plate 11.4.18 Viewpoint 2.1: summer view

Date taken: 9 August 2011. 18mm lens.

11.4.103 In summer, the view towards the site (illustrated in Vol 18 Plate 11.4.18) is largely unchanged, although the avenue of London plane trees in the background of the view is more distinct.

11.4.104 At night, the most elements of the view comprise the lit building facades of premises immediately to the north of the site, and the distinctive blue lighting of the festoon lighting along Victoria Embankment. In the background of the view, lighting along Victoria Embankment is heavily filtered by the avenue of mature London plane trees.

11.4.105 A baseline description of the Grade II listed Blackfriars Bridge as a heritage asset is provided in Section 7.4 of this volume.

Viewpoint 2.2: View west from the Millennium Bridge (LVMF River Prospect)

11.4.106 This viewpoint is in the same location as a River Prospect in the LVMF (Millennium Bridge viewing location 13A.1), although the focus of the designated view is St Paul’s Cathedral. The viewpoint is representative of the typical view for pedestrians walking across the Millennium Bridge.

Vol 18 Plate 11.4.19 Viewpoint 2.2: winter view

Date taken: 29 November 2011. 18mm lens.

11.4.107 The view (illustrated in Vol 18 Plate 11.4.19) is dominated by Blackfriars railway bridge in the middle ground, limiting views further upstream. Commercial premises on the south bank (right hand side of the image) frame the view up the river, while the Victoria and Edwardian buildings immediately behind the site, and Sea Containers House on the north bank frame the background of the view. The existing river wall and Millennium Pier at the site can be intermittently glimpsed through the arches of Blackfriars Bridge and Blackfriars railway bridge. While the image illustrates cranes on Blackfriars railway bridge, this work has since been completed.

Vol 18 Plate 11.4.20 Viewpoint 2.2: summer view

Date taken: 9 August 2011. 18mm lens.

11.4.108 In summer, the view towards the site (illustrated in Vol 18 Plate 11.4.20) is largely unchanged.

Viewpoint 2.3: View northwest from the South Bank outside Tate Modern

11.4.109 This viewpoint is representative of the typical view for recreational users of South Bank Jubilee Walkway at the entrance to the Tate Modern art gallery.

Vol 18 Plate 11.4.21 Viewpoint 2.3: winter view

Date taken: 29 November 2011. 18mm lens.

11.4.110 The view (illustrated in Vol 18 Plate 11.4.21) across the river is dominated by Blackfriars railway bridge (left hand side), commercial premises on the river frontage of the north bank and the dome of St Paul's Cathedral. The view towards the Blackfriars Bridge Foreshore main site is obstructed by the arches of Blackfriars railway bridge, although the view of the Blackfriars Pier site would be unobstructed. While the image illustrates cranes on Blackfriars railway bridge, this work has since been completed.

Vol 18 Plate 11.4.22 Viewpoint 2.3: summer view

Date taken: 9 August 2011. 18mm lens.

11.4.111 In summer, the view towards the site (illustrated in Vol 18 Plate 11.4.22) is largely unchanged.

Viewpoint 2.4: View north from the South Bank outside Sea Containers House

11.4.112 This viewpoint is representative of the typical view for recreational users of South Bank Jubilee Walkway in front of Sea Containers House.

Vol 18 Plate 11.4.23 Viewpoint 2.4: winter view

Date taken: 29 November 2011. 18mm lens.

11.4.113 The view (illustrated in Vol 18 Plate 11.4.23) is a wide panorama of the river, framed by Blackfriars Bridge on the right hand side of the image. The view is dominated by the Victorian and Edwardian building façades behind the site. Further to the west (on the left hand side of the image), the view is characterised by the mature avenue of London plane trees along Victoria Embankment. Blackfriars Millennium Pier forms a component in the foreground of the view. Views of the site are unobstructed from this location. While the image illustrates cranes on Blackfriars railway bridge, this work has since been completed.

Vol 18 Plate 11.4.24 Viewpoint 2.4: summer view

Date taken: 9 August 2011. 18mm lens.

11.4.114 In summer, the view towards the site (illustrated in Vol 18 Plate 11.4.24) is largely unchanged.

11.4.115 At night, the view is dominated by decorative lighting on the facades of the buildings adjacent to the site, in addition to street lighting and light spill from vehicles along Victoria Embankment. However, the unlit expanse of river forms the key component of the foreground view at night.

Viewpoint 2.5: View northeast from Bernie Spain Gardens

11.4.116 This viewpoint is representative of the typical view for recreational users of Bernie Spain Gardens on the southern bank of the river.

Vol 18 Plate 11.4.25 Viewpoint 2.5: winter view

Date taken: 29 November 2011. 18mm lens.

11.4.117 The view (illustrated in Vol 18 Plate 11.4.25) is characterised by mature tree planting within the open space, which acts to partially screen views towards the river and the northern bank. Views through to the river are characterised by the mature avenue of London plane trees along Victoria Embankment, permanent moorings and Blackfriars Millennium Pier, set in front of the Victorian and Edwardian building façades. Views towards the site are partially screened by the mature tree planting within Bernie Spain Gardens.

Viewpoint 2.6: View northeast from Gabriel's Wharf viewing platform (LVMF River Prospect)

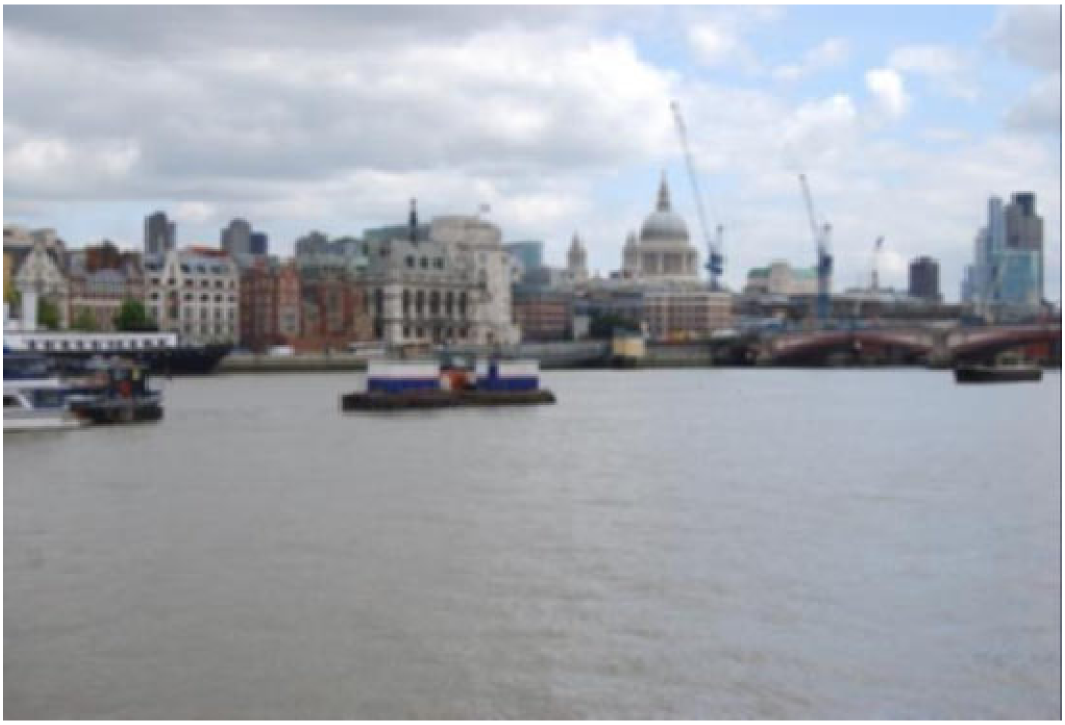
11.4.118 This viewpoint is recorded as a River Prospect in the LVMF (The South Bank: Gabriel's Wharf viewing platform, viewing location 16B.2). This viewpoint is representative of the view for recreational users of the South Bank, at the Gabriel's Wharf viewing platform.

Vol 18 Plate 11.4.26 Viewpoint 2.6: winter view

Date taken: 29 November 2011. 35mm lens.

11.4.119 The view (illustrated in Vol 18 Plate 11.4.26) is characterised by a wide panorama of the River Thames, towards St Paul’s Cathedral and Blackfriars Bridge. The view across the river is dominated by the Victorian and Edwardian building façades along the river frontage, immediately behind the site. The President moored ship and the Millennium Pier form key components in the foreground of the view. Tall buildings in the City of London form a component of the background of the view (on the far right hand side of the image). Views of the site are unobstructed from this location. While the image illustrates cranes on Blackfriars railway bridge, this work has since been completed.

Vol 18 Plate 11.4.27 Viewpoint 2.6: summer view



Date taken: 9 August 2011. 35mm lens.

11.4.120 In summer, the view towards the site (illustrated in Vol 18 Plate 11.4.27) is largely unchanged.

11.4.121 At night, the view is characterised by decorative lighting on the facades of the buildings adjacent to the site, in addition to street lighting and light spill from vehicles along Victoria Embankment. The brightly lit dome of St Paul's Cathedral forms the key component in the background of the view, forming a distinctive element of the night time skyline. This lighting is prominently reflected in the river, although the foreground of the view is entirely unlit.

Viewpoint 2.7: View northeast from Waterloo Bridge (LVMF River Prospect)

11.4.122 This viewpoint is recorded as a River Prospect in the LVMF (Waterloo Bridge: downstream, viewing location 15B.2). This viewpoint is representative of the typical view for pedestrians crossing Waterloo Bridge.

Vol 18 Plate 11.4.28 Viewpoint 2.7: winter view

Date taken: 29 November 2011. 35mm lens.

11.4.123 The view (illustrated in Vol 18 Plate 11.4.28) is linear in nature along the river towards Blackfriars Bridge to the east. The foreground of the view across the river is dominated by the avenue of mature London plane trees lining Victoria Embankment, in addition to permanent moorings including the President vessel partially within the Blackfriars Bridge Foreshore main site. St Paul's Cathedral forms the middle ground of the view, while tall buildings in the City of London form the backdrop. Views of Blackfriars Bridge Foreshore are largely unobstructed from this location. While the image illustrates cranes on Blackfriars railway bridge, this work has since been completed. In addition, the wooden structure upstream from the President vessel has since been replaced with a new pier including a ramp up and over the river wall.

Vol 18 Plate 11.4.29 Viewpoint 2.7: summer view

Date taken: 9 August 2011. 35mm lens.

11.4.124 In summer, the view towards the site (illustrated in Vol 18 Plate 11.4.29) is largely unchanged, although the avenue of London plane trees along Victoria Embankment forms a stronger component of the view.

11.4.125 At night, the background of the view is characterised by decorative lighting on the facades of the buildings adjacent to the site, in addition to street lighting and light spill from vehicles along Victoria Embankment. Lighting along Victoria Embankment in the middle ground of the view is heavily filtered by the avenue of mature London plane trees. The brightly lit dome of St Paul's Cathedral forms the key component in the background of the view, forming a distinctive element of the night time skyline, alongside tall buildings in the City of London. This lighting is prominently reflected in the river, although the foreground of the view is entirely unlit.

11.4.126 This viewpoint is also located within the ZTV of the proposed Thames Tideway Tunnel project site at Victoria Embankment Foreshore (refer to para. -11.3.14). However, Waterloo Bridge obscures visibility of the Victoria Embankment Foreshore site from this viewpoint. Therefore the Victoria Embankment Foreshore site is not considered further in the assessment of effects on this viewpoint.

Viewpoint 2.8: View east from the northern end of Waterloo Bridge

11.4.127 This viewpoint is representative of the typical view for pedestrians crossing Waterloo Bridge, towards the northern end of the bridge.

Vol 18 Plate 11.4.30 Viewpoint 2.8: winter view

Date taken: 29 November 2011. 18mm lens.

11.4.128 The view (illustrated in Vol 18 Plate 11.4.30) is linear in nature along the river towards Blackfriars Bridge to the east (far right of the image). The view along the north bank is dominated by the avenue of mature London plane trees lining Victoria Embankment and moored vessels (including the President in the background of the view). The dome of St Paul's Cathedral and tall buildings within the City of London form the backdrop to the view. Views of the Blackfriars Bridge Foreshore main site are largely unobstructed from this location, apart from permanent moorings along Victoria Embankment. While the image illustrates cranes on Blackfriars railway bridge, this work has since been completed. In addition, the wooden structure upstream from the President vessel has since been replaced with a new pier including a ramp up and over the river wall.

Vol 18 Plate 11.4.31 Viewpoint 2.8: summer view

Date taken: 9 August 2011. 18mm lens.

11.4.129 In summer, the view towards the site (illustrated in Vol 18 Plate 11.4.31) is largely unchanged, although the avenue of London plane trees along Victoria Embankment forms a stronger component of the view.

11.4.130 At night, lighting along Victoria Embankment is heavily filtered by the avenue of mature London plane trees, although the lack of trees adjacent to the site highlights the decorative facade lighting of buildings close to Blackfriars Bridge. The brightly lit dome of St Paul's Cathedral forms the key component in the background of the view, forming a distinctive element of the night time skyline, alongside tall buildings in the City of London. This lighting is prominently reflected in the river, although the foreground of the view is entirely unlit.

11.4.131 This viewpoint is also located within the ZTV of the proposed Thames Tideway Tunnel project site at Victoria Embankment Foreshore (refer to para. 11.3.14). However, Waterloo Bridge obscures visibility of the Victoria Embankment Foreshore site from this viewpoint. Therefore the Victoria Embankment Foreshore site is not considered further in the assessment of effects on this viewpoint.

Viewpoint 2.9: View east and southwest from the Thames Path opposite Somerset House

11.4.132 This viewpoint is representative of the typical view for recreational users of the Thames Path, in front of Somerset House.

Vol 18 Plate 11.4.32 Viewpoint 2.9: winter view towards Blackfriars Bridge Foreshore (east)

Date taken: 15 February 2012. 35mm lens.

11.4.133 The view east (illustrated in Vol 18 Plate 11.4.32) is dominated by the avenue of mature London plane trees along Victoria Embankment, which partially screen views towards the Blackfriars Bridge Foreshore main site. Beyond the trees, moorings along Victoria Embankment are visible. Blackfriars Bridge and the Tate Modern art gallery are visible in the background of the view. While the image illustrates cranes on Blackfriars railway bridge, this work has since been completed.

Vol 18 Plate 11.4.33 Viewpoint 2.9: summer view towards Blackfriars Bridge Foreshore (east)

Date taken: 9 August 2011. 18mm lens.

11.4.134 In summer (illustrated in Vol 18 Plate 11.4.33), deciduous trees along Victoria Embankment provide further intermittent screening of the Blackfriars Bridge Foreshore main site.

11.4.135 This viewpoint is also located within the ZTV of the proposed Thames Tideway Tunnel project site at Victoria Embankment Foreshore (refer to para. 11.3.14).

Vol 18 Plate 11.4.34 Viewpoint 2.9: winter view towards Victoria Embankment Foreshore (southwest)

Date taken: 21 November 2011. 18mm lens.

11.4.136 The view southwest (illustrated in Vol 18 Plate 11.4.34) towards Victoria Embankment Foreshore is an open panorama across the River Thames towards Waterloo Bridge, which partially limits views further upstream. The foreground of the view across the river is dominated by Waterloo Bridge and adjacent moorings along Victoria Embankment. Views along the river are framed by the avenue of mature London plane trees along Victoria Embankment. The Golden Jubilee footbridges (adjacent to the Victoria Embankment Foreshore site), and the London Eye are visible in the background of the view. Views towards Victoria Embankment Foreshore are largely obscured by intervening permanent moorings and piers, Waterloo Bridge and the Golden Jubilee footbridges.

Vol 18 Plate 11.4.35 Viewpoint 2.9: summer view towards Victoria Embankment Foreshore (southwest)

Date taken: 12 August 2011. 18mm lens.

11.4.137 In summer (illustrated in Vol 18 Plate 11.4.35), deciduous trees in the foreground provide some intermittent screening of the Victoria Embankment Foreshore site.

Viewpoint 2.10: View east from the Thames Path opposite Temple Place

11.4.138 This viewpoint is recorded as a Local View in the City of Westminster UDP. This viewpoint is representative of the typical view for pedestrians using the Thames Path along Victoria Embankment.

Vol 18 Plate 11.4.36 Viewpoint 2.10: winter view

Date taken: 29 November 2011. 35mm lens.

11.4.139 The view (illustrated in Vol 18 Plate 11.4.36) is focused along Victoria Embankment, and is characterised by the road and associated avenue of mature London plane trees that runs along its length. Blackfriars Bridge forms the background to the view, partially screened by the mature tree cover and permanent moorings along the river. The Blackfriars Bridge Foreshore main site is partially visible through this tree cover. While the image illustrates cranes on Blackfriars railway bridge, this work has since been completed.

Vol 18 Plate 11.4.37 Viewpoint 2.10: summer view

Date taken: 9 August 2011. 35mm lens.

11.4.140 In summer, the view (illustrated in Vol 18 Plate 11.4.37) is largely unchanged, although the mature avenue of London plane trees along Victoria Embankment forms a more dominant component of the view.

11.4.141 This viewpoint is also located within the ZTV of the proposed Thames Tideway Tunnel project site at Victoria Embankment Foreshore (refer to para. -11.3.14). However, the moorings and piers along the northern bank obscure the Victoria Embankment Foreshore site from this viewpoint. Therefore the Victoria Embankment Foreshore site is not considered further in the assessment of effects on this viewpoint.

Viewpoint 2.11: View east from the Thames Path opposite Milford Lane

11.4.142 This viewpoint is representative of the typical view for pedestrians using the Thames Path along Victoria Embankment.

Vol 18 Plate 11.4.38 Viewpoint 2.11: winter view

Date taken: 29 November 2011. 18mm lens.

11.4.143 The view (illustrated in Vol 18 Plate 11.4.38) is focused along Victoria Embankment, and is characterised by the riverside avenue of mature London plane trees and permanent moorings along the northern bank (including the President vessel). Blackfriars Bridge forms the middle ground of the view, limiting views further downstream. The site is partially visible beyond the permanent moorings along the northern bank. While the image illustrates cranes on Blackfriars railway bridge, this work has since been completed. In addition, the wooden structure upstream from the President vessel (in the foreground of the view) has since been replaced with a new pier including a ramp up and over the river wall.

Vol 18 Plate 11.4.39 Viewpoint 2.11: summer view

Date taken: 9 August 2011. 18mm lens.

11.4.144 In summer, the view towards the site (illustrated in Vol 18 Plate 11.4.39) is largely unchanged, although the mature avenue of London plane trees along Victoria Embankment is a more dominant component of the view.

11.4.145 At night, the foreground of the view is characterised by street lighting and light spill from vehicles and buildings along Victoria Embankment. Lighting along Blackfriars Bridge and festoon lighting on the President is intermittently visible in the background of the view.

11.4.146 This viewpoint is also located within the ZTV of the proposed Thames Tideway Tunnel project site at Victoria Embankment Foreshore (refer to para. 11.3.14). However, the moorings and piers along the northern bank, and Waterloo Bridge obscure the Victoria Embankment Foreshore site from this viewpoint. Therefore the Victoria Embankment Foreshore site is not considered further in the assessment of effects on this viewpoint.

Viewpoint 2.12: View east from the Thames Path opposite Inner Temple Garden

11.4.147 This viewpoint is representative of the typical view for pedestrians using the Thames Path along Victoria Embankment.

Vol 18 Plate 11.4.40 Viewpoint 2.12: winter view

Date taken: 29 November 2011. 18mm lens.

11.4.148 The view (illustrated in Vol 18 Plate 11.4.40) is focused along Victoria Embankment, and is characterised by the riverside avenue of mature London plane trees. Blackfriars Bridge forms the background of the view, limiting views further downstream. The Shard high rise building is visible in the background of the view on the south bank (far right of the image). The site is visible in the middle ground of the view. While the image illustrates cranes on Blackfriars railway bridge, this work has since been completed.

Vol 18 Plate 11.4.41 Viewpoint 2.12: summer view

Date taken: 9 August 2011. 18mm lens.

11.4.149 In summer, the view towards the site (illustrated in Vol 18 Plate 11.4.41) is largely unchanged.

11.4.150 At night, the foreground of the view is characterised by street lighting, blue tinted festoon lighting and light spill from vehicles and buildings along Victoria Embankment. Lighting along Blackfriars Bridge is intermittently visible in the background of the view. Lighting on the Shard (in London Bridge) forms a key component of the night time skyline.

11.4.151 This viewpoint is also located within the ZTV of the proposed Thames Tideway Tunnel project site at Victoria Embankment Foreshore (refer to para. 11.3.14). However, the moorings and piers along the northern bank, and Waterloo Bridge obscure the Victoria Embankment Foreshore site from this viewpoint. Therefore the Victoria Embankment Foreshore site is not considered further in the assessment of effects on this viewpoint.

View 2.13: View south from Temple Avenue

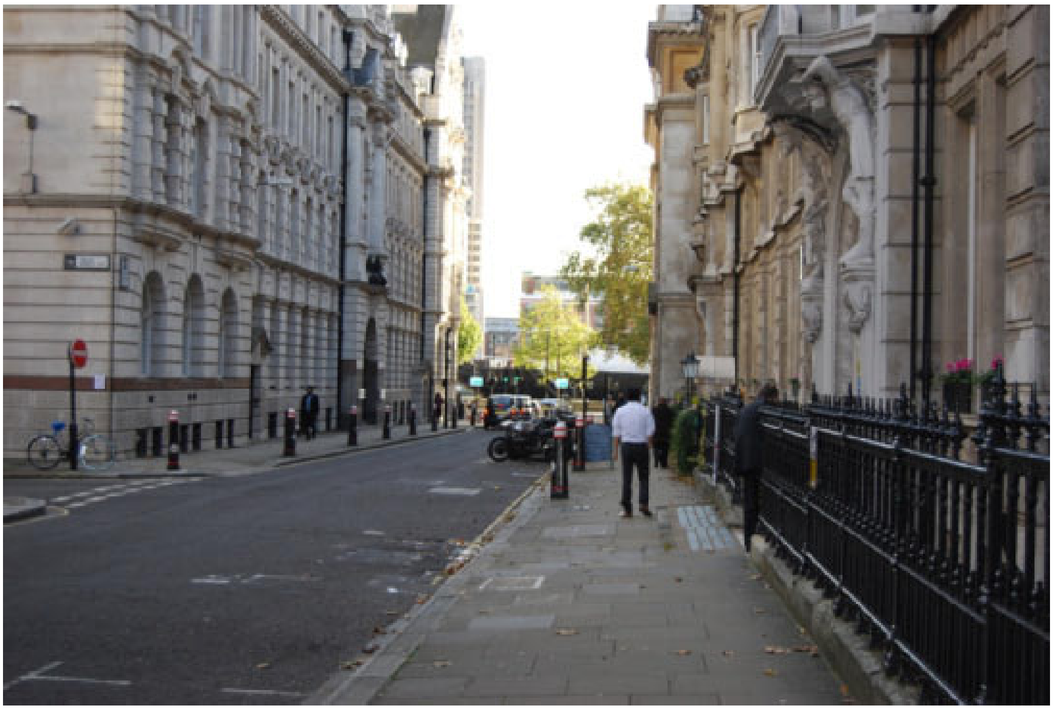
11.4.152 This viewpoint is representative of the typical view for pedestrians at Temple Avenue.

Vol 18 Plate 11.4.42 Viewpoint 2.13: winter view

Date taken: 20 November 2012. 35mm lens.

11.4.153 The view (illustrated in Vol 18 Plate 11.4.42) is linear in nature and slopes down to the River Thames. It is characterised by office buildings along both sides of Temple Avenue. The background of the view is characterised by the 'President' which is partially obscured by the branches of the existing trees.

Vol 18 Plate 11.4.43 Viewpoint 2.13: summer view



Date taken: 16 October 2012. 35mm lens.

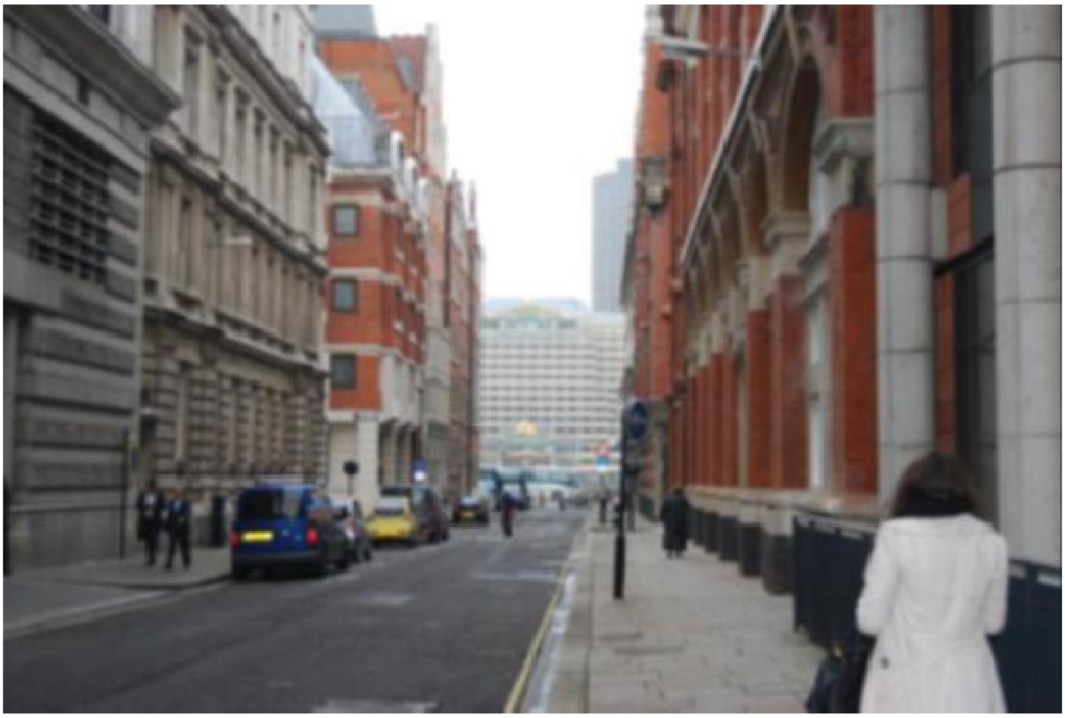
11.4.154 During summer, the view (illustrated in Vol 18 Plate 11.4.43) towards the site is partially obscured by intervening trees.

11.4.155 At night, the background of the view is characterised by street lighting, light spill from vehicles and buildings along the River Thames and festoon lighting on the 'President'.

Viewpoint 2.14: View south from the corner of Tudor Street and Carmelite Street

11.4.156 This viewpoint is representative of the typical view for pedestrians at the junction of Tudor Street and Carmelite Street.

Vol 18 Plate 11.4.44 Viewpoint 2.14: winter view



Date taken: 29 November 2011. 18mm lens.

11.4.157 The view (illustrated in Vol 18 Plate 11.4.44) is linear in nature along Carmelite Street which slopes down towards the River Thames. The view is enclosed by commercial buildings along both sides of Carmelite Street. The background of the view is dominated by Sea Containers House on the opposite bank of the river, immediately behind the site.

11.4.158 During summer, the view towards the site is unchanged due to the lack of vegetation within the view. Therefore, no photo is included during summer.

Employment

11.4.159 People at work are the least sensitive receptors, as their attention is likely to be focused on their work activity. These receptors have a low sensitivity to change.

Viewpoint 4.1: View south from the office buildings along Victoria Embankment

11.4.160 This viewpoint is representative of the view for people working in the offices along Victoria Embankment immediately north of the site.

Vol 18 Plate 11.4.45 Viewpoint 4.1: winter view

Date taken: 29 November 2011. 18mm lens.

11.4.161 The foreground of the view towards the site (illustrated in Vol 18 Plate 11.4.45) is dominated by traffic along Victoria Embankment and an open aspect across the river (from upper storeys). The background of the view is dominated by London landmark buildings including the Oxo Tower (in the left of the image) and the London Eye (in the centre of the view). Views of the site are largely unobstructed from this location, apart from by vehicles along Victoria Embankment and the ramp connecting Victoria Embankment and Blackfriars Bridge, which detract from the existing view.

Vol 18 Plate 11.4.46 Viewpoint 4.1: summer view

Date taken: 9 August 2011. 18mm lens.

11.4.162 In summer, the view towards the site (illustrated in Vol 18 Plate 11.4.46) is largely unchanged.

11.4.163 At night, the foreground of the view is characterised by street lighting and light spill from vehicles and decorative facade lighting of the buildings along Victoria Embankment. The background of the view across the river is characterised by decorative lighting on the Oxo Tower in addition to public realm lighting along South Bank. Lighting on the London Eye forms a key component of the night time skyline.

Construction base case

11.4.164 The base case in Site Year 2 of construction taking into account the schemes described in para. 11.3.15 would change the following townscape character areas:

a. City of London Mixed Use TCA – The Puddle Dock Mermaid Theatre hotel would be located within this character area, locally altering the character in the vicinity of Blackfriars Bridge. However, the overall sensitivity of the area would remain high, as described in para. 11.4.56.

b. Tate Modern TCA – The extension of the art gallery would be located within this character area, but would not substantially affect the overall character or the sensitivity described in para. 11.4.61, which would remain high.

c. Southwark Mixed Use TCA – The character of the wider area would be altered by the assumed completion of the following developments:

i Bankside mixed use development

ii mixed use development at 20 Blackfriars Road

iii 11 storey commercial development at Wedge House (32-40 Blackfriars Road)

iv residential and hotel development at 1-16 Blackfriars Road

v commercial and retail 20 storey development at 231-241 Blackfriars Road.

d. However, despite the extensive regeneration, the sensitivity of the character area as a whole, which would be largely unchanged along the river frontage, would remain high as described in para. 11.4.66.

e. South Bank Conservation Area TCA – The character of this area would be altered to a limited extent by the assumed completion of the following developments:

i the extension of the London Eye Pier

ii Elizabeth House commercial, retail and residential development

iii the mixed use development between Upper Ground and Doon Street.

f. However, despite these changes across the character area, the sensitivity of this character area would remain high, as described in para. 11.4.72.

11.4.165 All other receptors would remain as detailed in the baseline.

Operational base case

11.4.166 The operational phase assessment has been undertaken for Year 1 of operation and Year 15 of operation. For the purposes of the operational assessments, it is assumed there would be no further substantial changes in the townscape and visual baseline, beyond those described in paras. 11.4.164 to 11.4.165, between 2012 and Year 1 and Year 15 of operation.

11.5 Construction effects assessment

11.5.1 The following section describes the likely significant effects arising from construction at Blackfriars Bridge Foreshore taking account of Victoria Embankment Foreshore (as detailed in Section 11.3).

11.5.2 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[13] 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 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 plant being required at the time and a reduced intensity of construction activity.

11.5.3 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

Blackfriars Bridge Foreshore main site

11.5.4 Effects on the character of the Blackfriars Bridge Foreshore main site would arise from partial removal of the river wall, removal of lamp standards, installation of site hoardings, removal of the Millennium Pier (for relocation in the Blackfriars Pier site described below) and construction activity associated with the construction of the cofferdam, piled deck, shaft and ventilation equipment, and secondary lining of the tunnel. The impacts on specific components of the site are described in Vol 18 Table 11.5.1.

Vol 18 Table 11.5.1 Townscape – construction impacts within the site

ID	Component	Impacts
01	Blackfriars Millennium Pier	During construction, the pier would be relocated to the east of Blackfriars Bridge and Blackfriars railway bridge
02	Grade II listed river wall	To facilitate access onto the site from Victoria Embankment, the section of the river wall above pavement level would require removal. In addition, the temporary cofferdam forming the site would be joined into the existing structure to ensure the resilience of the flood defences are retained during the works.
03	Reconstructed river wall	To facilitate access onto the site from Victoria Embankment, the section of the river wall above pavement level would require removal. In addition, the temporary cofferdam forming the site would be joined into the existing structure to ensure the resilience of the flood defences are retained during the works.
04	Lamp standards	Five lamp standards would require removal and careful storage during construction, four of which are listed. All the listed lamp standards would be reinstated following construction. I
05	Mature trees	Existing trees towards the edge of the site would be protected in accordance with BS5837 – Trees in relation to construction – Recommendations. One mature London plane tree at the west of the site would require removal to facilitate construction.
06	Thames Path	During construction, the Thames Path would be diverted to the opposite side of Victoria Embankment. The existing paving would be

ID	Component	Impacts
		removed for the duration of construction.
07	President	The ship would be temporarily relocated to the Chrysanthemum Pier immediately upstream of its existing location. The pier may require modification to accommodate the President.

11.5.5 The low level of tranquillity at the main site would be further reduced by the introduction of construction vehicles, plant equipment and high levels of activity in the river corridor.

11.5.6 Therefore, due to the high level of change to character and further reduction in levels of tranquillity, the overall magnitude of change to the main site during construction is considered to be high.

11.5.7 The high magnitude of change, assessed alongside the high sensitivity of the main site, would result in **major adverse** effects.

11.5.8 The assessment of specific effects on the setting of Whitefriars Conservation Area as a heritage asset is set out in Section 7 of this volume. The historic environment assessment identifies a moderate adverse effect on the setting of this asset as the conservation area is larger than the area defined as the site. Therefore, the change within the site affect only a proportion of the conservation area, with part of the setting unaffected.

Blackfriars Pier site

11.5.9 Effects on the character of the Blackfriars Pier site would arise from removal of lamp standards, installation of site hoardings and relatively low levels of construction activity associated with the relocation of the pier.

11.5.10 The low level of tranquillity at the Blackfriars Pier site would be affected to a limited extent by the low levels of construction activity associated with the relocation of the pier.

11.5.11 Therefore, due to the relatively limited changes to character and tranquillity, the overall magnitude of change to the Blackfriars Pier site is considered to be low.

11.5.12 The low magnitude of change, assessed alongside the high sensitivity of the Blackfriars Pier site, would result in **minor adverse** effects.

Townscape character areas assessment

River Thames – Central London Reach TCA

11.5.13 High levels of construction activity would be introduced within a part of the river currently partly occupied by the Blackfriars Millennium Pier. This activity would be set in front of the existing façades of Victorian and Edwardian buildings, adversely affecting the strong linear stretch of the river defined by Victoria Embankment along the northern bank. Between Waterloo Bridge and Blackfriars Bridge, the reach would be heavily affected by construction activity associated with the site.

11.5.14 The Victoria Embankment Foreshore site is located approximately 400m south of this reach of the river, separated by Hungerford Bridge and Waterloo Bridge. Construction activity would take place within the wider setting of this character area, but would be largely screened by the presence of the two bridges. The setting would be affected to a limited extent by the site cofferdam and presence of tall construction plant and cranes.

11.5.15 The low levels of tranquillity in the area would be affected to a limited extent by construction activity at both sites, principally piling and ongoing activities at the Blackfriars Bridge Foreshore site.

11.5.16 Therefore, due to the level of construction activity at both the proposed sites, the magnitude of change is considered to be high.

11.5.17 The high magnitude of change, assessed alongside the high sensitivity of this character area, would result in **major adverse** effects.

River Thames – Victoria Embankment Gardens and Jubilee Gardens Reach TCA

11.5.18 The proposed Blackfriars Bridge Foreshore site is approximately 200m east of this reach of the river, separated by Waterloo Bridge. The character of the northern section of this character area (between Hungerford Bridge and Waterloo Bridge) would be affected by the wider presence of the site cofferdam, construction activity and construction plant at the Blackfriars Bridge Foreshore site.

11.5.19 The Victoria Embankment Foreshore site is located adjacent to this reach of the river. High levels of construction activity would be introduced across the green frontage of Victoria Embankment and Upper Victoria Embankment Gardens, adversely affecting the strong linear stretch of river defined by Victoria Embankment. The London Eye section of this reach (between Westminster Bridge and Hungerford Bridge) would be heavily affected by the site cofferdam, construction activity and construction plant. The wider setting of the remainder of the area would also be affected by the presence of tall construction plant and cranes.

11.5.20 The low levels of tranquillity in the area would be affected to a limited extent by construction activity at both sites, principally ongoing activities at the Victoria Embankment Foreshore site.

11.5.21 Therefore, due to the level of construction activity at both the proposed sites, the magnitude of change is considered to be high.

11.5.22 The high magnitude of change, assessed alongside the high sensitivity of this character area, would result in **major adverse** effects.

Whitefriars Conservation Area TCA

11.5.23 The proposed Blackfriars Bridge Foreshore site is set directly south of this character area, segregating the area from the River Thames. The setting of premises (Grade II listed) fronting Victoria Embankment would be affected by the presence of construction activity, traffic and cranes, particularly towards the western end of the character area, close to the proposed shaft location. The open setting of the character area across the river would be substantially altered by site hoardings, welfare facilities, construction plant and intermittent construction traffic along the busy Victoria Embankment.

11.5.24 The Victoria Embankment Foreshore site forms part of the wider riverside setting of this character area, although construction activities would be barely perceptible beyond construction activity at the Blackfriars Bridge Foreshore site.

11.5.25 The low levels of tranquillity in the area would be affected to a limited extent by construction activities at the Blackfriars Bridge Foreshore site.

11.5.26 Therefore, due to the changes in the immediate riverside setting introduced by construction at Blackfriars Bridge Foreshore, the magnitude of change is considered to be high.

11.5.27 The high magnitude of change, assessed alongside the high sensitivity of this character area would result in **major adverse** effects.

11.5.28 The assessment of specific effects on the setting of Whitefriars Conservation Area as a heritage asset is set out in Section 7 of this volume. The historic environment assessment identifies a moderate adverse effect on the setting of this asset as some key heritage areas of the conservation area would be largely unaffected.

City of London Mixed Use TCA

11.5.29 The proposed Blackfriars Bridge Foreshore main site forms part of the wider riverside setting of this character area. Tall construction plant and cranes at the main site would affect the wider setting to a limited extent, with the majority of other construction activities obscured by Blackfriars Bridge and Blackfriars railway bridge. A relatively small part of the immediate riverside setting would be affected by construction activity at the Blackfriars Pier site. The majority of the setting of the character area would remain largely unchanged.

11.5.30 The low levels of tranquillity in the area would be largely unaffected by construction activity at the main site and Blackfriars Pier site.

11.5.31 Therefore, due to the limited changes in a small part of the riverside setting, the magnitude of change is considered to be low.

11.5.32 The low magnitude of change, assessed alongside the high sensitivity of this character area, would result in **minor adverse** effects.

Tate Modern TCA

11.5.33 The proposed Blackfriars Bridge Foreshore main site forms part of the wider riverside setting of this character area. Tall construction plant and cranes at the main site would affect the wider setting to a limited extent, with the majority of other construction activities obscured by Blackfriars Bridge and Blackfriars railway bridge. The riverside setting would be affected by construction activity at the Blackfriars Pier site on the opposite side of the river, although this would not overly intrusive.

11.5.34 The low levels of tranquillity in the character area at present would be largely unaffected by construction activities at the main site and Blackfriars Pier site.

11.5.35 Therefore, due to the limited changes in the riverside setting, the magnitude of change is considered to be low.

11.5.36 The low magnitude of change, assessed alongside the high sensitivity of this character area, would result in **minor adverse** effects.

Southwark Mixed Use TCA

11.5.37 The proposed site forms a direct part of the riverside setting of this character area, despite the area being largely enclosed. Construction activity at the main site would affect the riverside setting of a small part of the character area, with construction activities obscured by Blackfriars Bridge and Blackfriars railway bridge for the majority of the area. The remainder of the river frontage would be affected by construction activity at the Blackfriars Pier site, on the opposite side of the river. The majority of the wider character area, which is inward looking in character, would be largely unaffected.

11.5.38 The low levels of tranquillity in the character area at present would be largely unaffected by construction activities at the main site and Blackfriars Pier site.

11.5.39 Therefore, due to the limited changes to part of the riverside setting arising from the main site and further changes to the remainder of the riverside setting arising from relatively unobtrusive construction activity at the Blackfriars Pier site, set against the majority of the wider setting being largely unaffected, the magnitude of change is considered to be low.

11.5.40 The low magnitude of change, assessed alongside the high sensitivity of this character area, would result in **minor adverse** effects.

South Bank Conservation Area TCA

11.5.41 The proposed Blackfriars Bridge Foreshore site forms part of the riverside setting of the northern section of this character area. The riverside setting of this part of the character area would be affected by the presence of the site cofferdam, piled deck, construction activity and construction plant on the opposite side of the river.

11.5.42 The Victoria Embankment Foreshore site forms a distinct part of the riverside setting of the London Eye section of this character area. The presence of the site cofferdam, construction activity and construction plant would substantially affect the riverside setting of the promenade and public spaces and buildings along the southern bank including Jubilee Gardens, County Hall and the Royal Festival Hall.

11.5.43 Tall construction plant and cranes at both sites would affect the riverside setting of the wider character area.

11.5.44 The low levels of tranquillity in the character area at present would be largely unaffected by construction activities at the two Thames Tideway Tunnel sites.

11.5.45 Therefore, due to the substantial changes in the riverside setting arising from construction at the Blackfriars Bridge Foreshore site (for the northern section of the character area) and the Victoria Embankment Foreshore site (for the London Eye section of the character area), the magnitude of change is considered to be high.

11.5.46 The high magnitude of change, assessed with the high sensitivity of this character area, would result in **major adverse** effects.

11.5.47 The assessment of specific effects on South Bank Conservation Area as a heritage asset is set out in Section 7 of this volume. The historic environment assessment identifies a moderate adverse effect on the setting of this asset as much of the historic setting of the area would be largely unaffected.

Victoria Embankment Administrative TCA

11.5.48 The proposed Blackfriars Bridge Foreshore site forms part of the wider riverside setting of the northern section of this character area. The riverside setting of this part of the character area would be affected to a limited extent by the wider presence of the site cofferdam, piled deck, construction activity and construction plant.

11.5.49 The Victoria Embankment Foreshore site is set directly east of this highly valued character area. The setting of the southern section of the character area, comprising Victoria Embankment Gardens, the National Liberal Club and Whitehall, would be affected by the presence of the site cofferdam, construction activity, construction plant and road traffic along the busy Victoria Embankment. The open setting of the character area would also be locally affected by site hoardings and welfare facilities. The setting of the Central section, located between Hungerford Bridge and Waterloo Bridge, would be largely unaffected, apart from by the wider presence of tall construction plant and cranes.

11.5.50 The low levels of tranquillity in the areas would be affected to a limited extent by construction activities at both sites.

11.5.51 Therefore, due to changes in part of the riverside setting caused by both sites, and limited changes to tranquillity, the magnitude of change is considered to be medium.

11.5.52 The medium magnitude of change, assessed alongside the high sensitivity of this character area, would result in **moderate adverse** effects.

Temples Conservation Area TCA

11.5.53 The proposed Blackfriars Bridge Foreshore site is set within the immediate riverside setting of this character area, segregating the area from the River Thames. The open setting of the character area across the river would be substantially altered by site hoardings, welfare facilities, construction plant and intermittent construction traffic along the busy Victoria Embankment.

11.5.54 The Victoria Embankment Foreshore site forms part of the wider riverside setting of this character area. The presence of tall construction plant and cranes would affect the riverside setting of the character area to a limited extent, although the site cofferdam and low level construction activity would be largely obscured by Waterloo Bridge and Hungerford Bridge.

11.5.55 The low levels of tranquillity in the area would be affected to a limited extent by construction activities at the Blackfriars Bridge Foreshore site.

11.5.56 Therefore, due to the changes in the immediate riverside setting introduced by construction at Blackfriars Bridge Foreshore and also the limited changes in the wider setting at Victoria Embankment Foreshore, the magnitude of change is considered to be high.

11.5.57 The high magnitude of change, assessed alongside the high sensitivity of this character area would result in **major adverse** effects.

11.5.58 The assessment of specific effects on the setting of Temples Conservation Area as a heritage asset is set out in Section 7 of this volume. The historic environment assessment identifies a moderate adverse effect on the setting of this asset as some key heritage areas of the conservation area would be largely unaffected.

Townscape – sensitivity test for programme delay

11.5.59 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. 11.5.4 to 11.5.58). 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 11.4.84).

Visual assessment

11.5.60 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.

London View Management Framework Linear Views

Linear View 8A.1 – Westminster Pier to St Paul's Cathedral

11.5.61 During construction, cranes at the site would be outside the viewing corridor. Other construction activity at the site would be obscured by the intervening low height buildings and structures. Therefore, the magnitude of change on this Linear View is considered to be negligible.

11.5.62 The negligible magnitude of change, assessed alongside the high sensitivity of the receptor, would result in a **negligible** effect.

Linear View 9A.1 – King Henry VIII's Mound, Richmond to St Paul's Cathedral

11.5.63 During construction, cranes at the site would be intermittently visible in the distant background of the view, set partially in front of St Paul's Cathedral. However, without the use of a telephoto lens, the cranes would be barely perceptible to recreational receptors at this location. Other construction activity at the site would be obscured by the intervening low height buildings and structures. Therefore, the magnitude of change on this long range Linear View is considered to be negligible.

11.5.64 The negligible magnitude of change, assessed alongside the high sensitivity of the receptor, would result in a **negligible** effect.

Residential

Viewpoint 1.1: View north from residences on the opposite river bank

11.5.65 Views from ground level towards the site would be characterised by the temporary cofferdam projecting into the river, site hoardings, welfare facilities, construction activity and construction plant. Views of the Victorian and Edwardian building façades along Victoria Embankment would be partially screened. From upper storeys, direct views of construction activity would be apparent within the site working boundary. Therefore, the magnitude of change is considered to be high.

11.5.66 The high magnitude of change, assessed alongside the high sensitivity of the receptor, would result in **major adverse** effects.

Viewpoint 1.2: View northwest and north from residences along Hopton Street on the opposite river bank

11.5.67 The view from this location towards the main site (to the northwest) would be affected to a limited extent by the visibility of tall construction plant and cranes, largely obscured by Blackfriars railway bridge and Blackfriars Bridge. The view north towards the Blackfriars Pier site would be affected by construction activity associated with the relocation of the pier, although this would not be overly visually intrusive. Therefore, the magnitude of change is considered to be low.

11.5.68 The low magnitude of change assessed, alongside the high sensitivity of the receptor, would result in **minor adverse** effects.

Recreational

Viewpoint 2.1: View northwest from Blackfriars Bridge (LVMF River Prospect)

11.5.69 Due to the elevated location of this viewpoint on Blackfriars Bridge, construction activity within the temporary cofferdam would be clearly visible beyond the hoardings at the site boundary. Construction plant, including the crane and piling rig, would partially obscure views to the Victorian and Edwardian building façades along Victoria Embankment, and would be visible in the linear view up the river towards Waterloo Bridge. Therefore, the magnitude of change is considered to be high.

11.5.70 The high magnitude of change, assessed alongside the high sensitivity of the receptor, would result in **major adverse** effects.

11.5.71 The assessment of specific effects on the setting of the Grade II listed Blackfriars Bridge as a heritage asset is set out in Section 7 of this volume. The historic environment assessment identifies a moderate adverse effect 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 unchanged, as opposed to the substantial change visible from this specific viewpoint.

Viewpoint 2.2: View west from the Millennium Bridge (LVMF River Prospect); and Viewpoint 2.3: View northwest from the South Bank outside Tate Modern

11.5.72 Works in the Blackfriars Pier site to relocate of the Millennium Pier would be visible on the north bank of the river in the middle ground of these views. Tall construction plant and cranes at the main site would be visible beyond Blackfriars railway bridge and Blackfriars Bridge, with the remainder of the construction activities largely obscured. Therefore, the magnitude of change is considered to be low.

11.5.73 The low magnitude of change, assessed alongside the high sensitivity of these receptors would result in **minor adverse** effects.

Viewpoint 2.4: View north from the South Bank outside Sea Containers House

11.5.74 Views across the river from this location would be characterised by the temporary cofferdam projecting into the river, welfare facilities, construction activity and construction plant. Views of the Victorian and Edwardian building façades along Victoria Embankment would be partially screened. Therefore, the magnitude of change is considered to be high.

11.5.75 The high magnitude of change, assessed alongside the high sensitivity of the receptor would result in **major adverse** effects.

Viewpoint 2.5: View northeast from Bernie Spain Gardens

11.5.76 The view of the construction site from this location would be partially screened by mature trees within Bernie Spain Gardens and also partially blocked by the Oxo Tower. Works associated with the construction, including the site cofferdam, construction activity and construction plant, would form noticeable components in the background of this view. Therefore, the magnitude of change is considered to be low.

11.5.77 The low magnitude of change, assessed alongside the high sensitivity of the receptor, would result in **minor adverse** effects.

Viewpoint 2.6: View northeast from Gabriel’s Wharf viewing platform (LVMF River Prospect)

11.5.78 Views across the river from this location would be characterised by the temporary cofferdam projecting into the river, welfare facilities, construction activity and construction plant. Views of the Victorian and Edwardian building façades along Victoria Embankment would be partially screened. Views towards St Paul’s Cathedral (the focus of the River Prospect) would also be intermittently blocked by tall construction plant and cranes. Therefore, the magnitude of change is considered to be high.

11.5.79 The high magnitude of change, assessed alongside the high sensitivity of the receptor, would result in **major adverse** effects.

Viewpoint 2.7: View northeast from Waterloo Bridge; and Viewpoint 2.8: View east from the northern end of Waterloo Bridge

11.5.80 Views from these locations down the river would encompass the temporary cofferdam projecting into the river, welfare facilities, construction activity and construction plant in the background of the view.

Views of the Victorian and Edwardian building façades along Victoria Embankment and St Paul's Cathedral would be intermittently obscured by tall construction plant and cranes. However, the foreground of the views would remain unaffected by the proposed works. Therefore, the magnitude of change is considered to be medium.

11.5.81 The medium magnitude of change, assessed alongside the high sensitivity of the receptor, would result in **moderate adverse** effects.

Viewpoint 2.9: View east and southwest from the Thames Path opposite Somerset House; and Viewpoint 2.10: View east and southwest from the Thames Path opposite Temple Place

11.5.82 Construction activity and the site cofferdam projecting into the river at the Blackfriars Bridge Foreshore site would be visible as noticeable elements in the middle ground of these views, set in front of Blackfriars Bridge. However, views of this site would be partially screened by the avenue of London plane trees and permanent moorings along Victoria Embankment, including the relocated ship 'President'. Wider views over the river would be largely unaltered.

11.5.83 The views towards the Victoria Embankment Foreshore site would be affected to a limited extent during construction. The site would be largely obscured by Hungerford Bridge in the background of the views and Waterloo Bridge in the foreground, although the site cofferdam, construction activity and construction plant towards the east of the site would be partially visible underneath the arches of Hungerford Bridge. The presence of tall construction plant and cranes at the site would be visible in the background of the views, above the line of Hungerford Bridge set behind the structure of the Golden Jubilee footbridges.

11.5.84 Therefore, due to the limited visibility of construction activity at both the Blackfriars Bridge Foreshore and Victoria Embankment Foreshore sites, the magnitude of change is considered to be low.

11.5.85 The low magnitude of change, assessed alongside the high sensitivity of these receptors would result in **minor adverse** effects.

Viewpoint 2.11: View east from the Thames Path opposite Milford Lane

11.5.86 Construction activity and the site cofferdam projecting into the river would be visible as noticeable elements in the middle ground of this view, set in front of Blackfriars Bridge. The view of the site would be partially screened by the avenue of London plane trees and permanent moorings along Victoria Embankment, including the relocated ship 'President'. Wider views over the river would be largely unaltered. Therefore, the magnitude of change is considered to be low.

11.5.87 The low magnitude of change, assessed alongside the high sensitivity of the receptor, would result in **minor adverse** effects.

Viewpoint 2.12: View east from the Thames Path opposite Inner Temple Gardens

11.5.88 From this location, the site hoardings, welfare facilities, construction activity and construction plant would form prominent components in the foreground of this view. Although the panoramic view across the river from this location would only be partially affected, views along Victoria Embankment (which are the most likely to be experienced by pedestrians walking along the path) would be characterised by construction activity at the site. However, the relocated ‘President’ would partially obscure views of the western extent of the site cofferdam and piled deck. Therefore, the magnitude of change is considered to be medium.

11.5.89 The medium magnitude of change, assessed alongside the high sensitivity of the receptor, would result in **moderate adverse** effects.

Viewpoint 2.13: View south from Temple Avenue

11.5.90 Views from this location down to the River Thames would be affected to a limited extent during construction by site hoardings and intermittently by construction activity including the crane, piling rig and other construction plant. However, the foreground of the view would remain unaltered. Therefore, the magnitude of change is considered to be low.

11.5.91 The low magnitude of change, assessed alongside the high sensitivity of the receptor, would result in **minor adverse** effects.

Viewpoint 2.14: View south from the corner of Tudor Street and Carmelite Street

11.5.92 Glimpsed views from this location down to the River Thames would be affected to a limited extent during construction by site hoardings and intermittently by construction activity including the crane, piling rig and other construction plant. Site hoardings would partially obscure views to the southern bank. However, the foreground of the view would remain unaltered. Therefore, the magnitude of change is considered to be low.

11.5.93 The low magnitude of change, assessed alongside the high sensitivity of the receptor, would result in **minor adverse** effects.

Employment

Viewpoint 4.1: View south from the office buildings along Victoria Embankment

11.5.94 Views from this location at ground level would be characterised by the site hoardings, welfare facilities and construction plant, visible beyond heavy traffic along Victoria Embankment. Views of the river, Blackfriars Bridge and the opposite river bank would be partially obscured. From higher levels, there would be direct views of construction activity within the site working boundary. Therefore, the magnitude of change is considered to be high.

11.5.95 The high magnitude of change, assessed alongside the low sensitivity of the receptor, would result in **moderate adverse** effects.

Visual effects – sensitivity test for programme delay

11.5.96 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. 11.5.61 to 11.5.95). 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. 11.4.86 to 11.4.163.

11.6 Operational effects assessment

11.6.1 The following section describes the likely significant effects arising during the operational phase at Blackfriars Bridge Foreshore taking account of the Victoria Embankment Foreshore site (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 summarised in para. 11.2.6. Where specific measures are of particular relevance to 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 18 Blackfriars Bridge Foreshore figures – Section 1) and design principles describing the environmental design measures are set out in Vol 1 Appendix B. Where photomontages have been prepared to assist the assessment of effects, these are references in the appropriate viewpoint below.

Operational effects Year 1

Site character assessment

Blackfriars Bridge Foreshore main site

11.6.5 The proposed development would have a permanent effect on the character of the Blackfriars Bridge Foreshore main site. The permanent layout would result in a new area of public realm along Victoria Embankment that would project into the river by approximately 35m. The projection would introduce a new structure into the river beyond the line of the river wall in a stretch of river characterised predominantly by small scale projections and other incursions that are temporary in nature, including moored vessels. However, the orthogonal design and geometry of the foreshore structure would be sympathetic to the historic character of the river in this location. The structure would be further integrated into the surrounding townscape character through use of natural stone on the river wall and the reinstatement of lions heads along the wall where possible. The river wall would incorporate vertical timber fenders and horizontal bands in the stone to mark river levels. The design intent for the river wall is illustrated on the Typical river wall design intent plan 1 and plan 2 (see separate volume of figures – Section 1).

11.6.6 A cluster of 4-8m high, well designed ventilation columns would be located in the western extent of the new foreshore structure, and the 2.5m high electrical and control kiosk near the shaft would be located along the landward edge of the foreshore structure on the line of the existing river wall. The design intent for the ventilation columns (which would be the project signature design) is illustrated on the Ventilation columns design intent figure – type C (see separate volume of figures – Section 1). An indicative drawing of the design intent for the electrical and control kiosk, which would be clad in granite on the walls and roof, is shown on the Kiosk and undercroft area design intent figure (see separate volume of figures – Section 1). An amenity kiosk, clad in granite and incorporating a brown roof, would also be located in the western section of the foreshore structure. The design intent for this structure is shown on the Kiosk design intent figure (see separate volume of figures – Section 1). The ventilation columns (forming the tallest element of the proposed development) comply with the requirements of the St Paul's Heights policy (City of London), which restricts the height of development in the vicinity of St Paul's Cathedral.

11.6.7 A further 3m high electrical and control kiosk would be located in the undercroft area which occupies the level difference between the foreshore structure and the ramp leading up to Blackfriars Bridge. Above this undercroft area would be a further 4-8m high signature design ventilation column serving the Fleet connection culvert and a narrow 6m high ventilation column serving the Northern Low Level Sewer No. 1.

11.6.8 The land based area of the construction site would be returned to its original condition at completion. The works would result in an improvement to the public realm underneath Blackfriars Bridge, through improving accessibility and removing components currently detrimental to the overall character of this part of the site. The impacts on specific components of the site are described in Vol 18 Table 11.6.1 below.

Vol 18 Table 11.6.1 Townscape – impacts on baseline components in Year 1 of operation

ID	Component	Impacts
01	Blackfriars Millennium Pier	The pier would be permanently relocated in the position adopted during construction, east of Blackfriars Bridge and Blackfriars railway bridge.
02	Grade II listed river wall	Sections of the listed river wall below ground level would be preserved behind the new flood defences. The majority of the upstand above flood defence level would be restored after construction, apart from stretches required to facilitate vehicular

ID	Component	Impacts
		access onto the foreshore structure and to allow interception of the low level sewer underneath Victoria Embankment. It is anticipated that material not reinstated would be used in the design of the new public realm or river wall.
03	Reconstructed river wall	Sections of the reconstructed river wall below ground level would be preserved behind the new flood defences. The majority of the upstand above flood defence level would be restored after construction, apart from stretches to facilitate vehicular access onto the foreshore structure and to allow interception of the low level sewer underneath Victoria Embankment. It is anticipated that material not reinstated would be used in the design of the new public realm or river wall.
04	Lamp standards	The four lamps on the listed section of the wall removed during construction would be reinstated at the end of the construction phase.
05	Mature trees	All trees within the site would be retained, with the exception of one tree to be removed at the western edge of the site
06	Thames Path	The Thames Path would be reinstated and resurfaced as part of the wider enhancement to the public realm.
07	President	The ship would be located back in her original position.

11.6.9 Although the character of some land based parts of the site would be improved, the overall change caused by the projection into the river in a highly sensitive townscape is considered to be adverse. However, the magnitude of change is considered to be low due to the commitment to a high quality design in keeping with the surrounding townscape (described in para. 11.2.6) in addition to the reinstatement of key components including the ‘President’ back to her original position.

11.6.10 The low magnitude of change, assessed alongside the high sensitivity of the main site, would result in **minor adverse** effects.

11.6.11 The assessment of specific effects on the setting of Whitefriars Conservation Area as a heritage asset is set out in Section 7 of this volume. The historic environment assessment identifies a moderate adverse effect on the setting of this asset due to the alteration to the setting of some key heritage assets, including the Grade II listed properties along the river frontage.

Blackfriars Pier site

11.6.12 The proposed development would have a permanent effect on the character of the pier site due to the relocation of the Millennium Pier, requiring access ramps over the existing river wall and the installation of a floating pier on the river. The new structures, including a new area of hardstanding, a pedestrian ramp, and a floating pontoon would introduce built elements into an area currently devoid of structures. The land based area of the construction site would be returned to its original or an improved condition at completion, including replacement of existing poor quality lamp standards with surplus ones from the main site and the Victoria Embankment Foreshore site. Therefore, the overall magnitude of change is considered to be negligible.

11.6.13 The negligible magnitude of change, assessed alongside the high sensitivity of the Blackfriars Pier site, would result in a **negligible** effect.

Townscape character areas assessment

11.6.14 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 substantially alter their setting:

a. River Thames – Victoria Embankment Gardens and Jubilee Gardens Reach TCA

b. City of London Mixed Use TCA

c. Tate Modern TCA

d. Victoria Embankment Administrative TCA.

River Thames – Central London Reach TCA

11.6.15 The proposed development at Blackfriars Bridge Foreshore would result in the alteration of the strong link between the river and Victoria Embankment due to the introduction of a large scale new foreshore structure that would project into the river by approximately 35m. The projection would introduce a new structure into the river beyond the line of the river wall in a stretch of river characterised predominantly by small scale projections and other incursions that are temporary in nature, including moored vessels. However, the orthogonal design and geometry of the foreshore structure, and the high quality materials and design proposed for the river wall would be sympathetic to the character of the surrounding townscape. The above ground structures, including the signature design ventilation columns and electrical and control kiosks, would introduce new built elements into the area, but their design, facade materials and locations would suit the character of the sensitive townscape.

11.6.16 The Victoria Embankment Foreshore site would also result in changes to the wider setting of this character area, due to the introduction of new built elements in front of the existing river wall, including the foreshore structure (projecting into the river by approximately 32m), control kiosks and ventilation columns.

11.6.17 The overall change caused by the projection of the Blackfriars Bridge Foreshore site into the river in a highly sensitive townscape, in addition to the projection of the Victoria Embankment Foreshore site in the adjacent river reach, forming part of the wider setting, is considered to be adverse. However, the magnitude of change is considered to be low due to the commitment to a high quality design in keeping with the surrounding townscape (described in para. 11.2.6).

11.6.18 The low magnitude of change, assessed alongside the high sensitivity of this character area, would result in **minor adverse** effects.

Whitefriars Conservation Area TCA

11.6.19 The proposed development would result in localised improvements to the immediate riverside setting of this character area, due to removal of a number of structures that currently degrade the townscape setting. The character of the Thames Path along the frontage of this area would be improved, with the creation of new high quality public realm. The public realm on the foreshore structure would further improve the riverside setting of this area, although it would project into the river by approximately 35m. This would particularly affect the setting of Grade II listed premises fronting onto Victoria Embankment (the assessment of specific effects on the setting of these historic assets is set out in Section 7 of this volume). The effect on the river setting would be minimised through the planting of semi mature London plane trees along Victoria Embankment, reducing the apparent bulk of the foreshore structure from this character area. Furthermore, the landward setting of this character area would be unaffected by the proposed development.

11.6.20 The overall change caused by the substantial improvements to the immediate setting of this area, set against the new foreshore structure projecting into a sensitive stretch of river, is considered to be adverse. However, the magnitude of change is considered to be low due to the commitment to a high quality design in keeping with the surrounding townscape (described in para. 11.2.6).

11.6.21 The low magnitude of change, assessed alongside the high sensitivity of this character area, would result in **minor beneficial** effects.

11.6.22 The assessment of specific effects on the setting of Whitefriars Conservation Area as a heritage asset is set out in Section 7 of this volume. The historic environment assessment identifies a moderate adverse effect on the setting of this asset due to the alteration to the setting of some key heritage assets, including the Grade II listed properties along the river frontage.

Southwark Mixed Use TCA

11.6.23 The foreshore structure at the main site (projecting into the river by approximately 35m) would affect a small part of the riverside setting of this character area, locally altering the character of the river to the west of Blackfriars Bridge. However, due to the commitment to a high quality design (described in para. 11.2.6), including use of natural stone for the river wall, visually unobtrusive railings and materials appropriate to the character of the surrounding townscape for the above ground structures, the change to setting would be barely perceptible. The Blackfriars Pier site would be located within the remainder of the riverside setting for this character area, but would be barely perceptible. Furthermore, the wider setting of this character area, inland from the river, would be unaffected by the proposed development. Therefore, the magnitude of change is considered to be negligible.

11.6.24 The negligible magnitude of change, assessed alongside the high sensitivity of this character area, would result in a **negligible** effect.

South Bank Conservation Area TCA

11.6.25 The foreshore structure at the Blackfriars Bridge Foreshore site (projecting into the river by approximately 35m) would affect the riverside setting of the northern section of this character area, locally altering the character of the river to the west of Blackfriars Bridge. The setting would be affected through the introduction of the foreshore structure and additional above ground structures (signature design ventilation columns and electrical and control kiosks) into a section of the river currently only characterised by the presence of the Millennium Pier. However, the magnitude of change would be minimised through the reinstatement of the ‘President’ vessel upstream of the foreshore structure, and the commitment to a high quality design (described in para. 11.2.6), including use of natural stone for the river wall, visually unobtrusive railings and materials appropriate to the character of the surrounding townscape for the above ground structures.

11.6.26 The proposed development at the Victoria Embankment Foreshore site, comprising a foreshore structure (projecting into the river by approximately 32m) and above ground structures would affect the riverside setting of the London Eye section of this character area. The setting would be affected through the introduction of a relatively large structure into the river, not entirely in keeping with the character of other projections (which comprise small scale monumental projections such as the RAF Memorial in addition to a number of permanent moorings). However, the retention of the Hispaniola vessel upstream of the site and repositioning of the Tattershall Castle vessel downstream of the site, in conjunction with the commitment to a high quality design in keeping with the character of the surrounding townscape (described in full in Volume 17), would minimise the magnitude of change arising from the Victoria Embankment Foreshore site.

11.6.27 Therefore, due to the changes in riverside setting caused by both the Blackfriars Bridge site (northern section of the character area) and the Victoria Embankment Foreshore site (London Eye section of the character area), set against the high quality design principles described in para. 11.2.6 and the positioning of vessels alongside the foreshore structures, the magnitude of change is considered to be low.

11.6.28 The low magnitude of change, assessed alongside the high sensitivity of this character area, would result in **minor adverse** effects.

11.6.29 The assessment of specific effects on the setting of South Bank Conservation Area as a heritage asset is set out in Section 7 of this volume.

Temples Conservation Area TCA

11.6.30 The proposed development would result in this character area being further segregated from the River Thames by virtue of the new foreshore structure that would project into the river by approximately 35m. The effect on the river setting would be minimised through the planting of semi mature London plane trees along Victoria Embankment, reducing the apparent bulk of the foreshore structure from these character areas. Furthermore, the landward setting of this character area would be unaffected by the proposed development.

11.6.31 The overall change caused by the projection of the Blackfriars Bridge Foreshore site into the river in a highly sensitive townscape, altering the riverside setting of this character area is considered to be adverse. However, the magnitude of change is considered to be low due to the commitment to a high quality design in keeping with the surrounding townscape (described in para. 11.2.6).

11.6.32 The low magnitude of change, assessed alongside the high sensitivity of this character area, would result in **minor adverse** effects.

11.6.33 The assessment of specific effects on the setting of Temples Conservation Area as a heritage asset is set out in Section 7 of this volume.

Townscape – sensitivity test for programme delay

11.6.34 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 11.6.33). 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 11.4.84).

Visual assessment

11.6.35 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 at daytime, the second part relates to visual effects during summer at daytime and the final part relates to visual effects at night time arising from operational lighting.

11.6.36 No assessment of visual effects has been made for the following viewpoints, as the components of the operational scheme would either not be visible, or would be barely perceptible in the background of the view:

a. Linear View 8A.1 – Westminster Pier to St Paul’s Cathedral

b. Linear View 9A.1 – King Henry VIII’s Mound, Richmond to St Paul’s Cathedral

c. Viewpoint 2.5: View northeast from Bernie Spain Gardens

d. Viewpoint 2.13: View south from Temple Avenue

11.6.37 The night time assessment considers effects arising from feature lighting of the ventilation columns. Other public realm and operational lighting requirements have not been assessed on the basis that they would be low level, capped and direction, providing lighting for the immediate area only. Therefore, no assessment of visual effects at night time has been made for the following viewpoints, as the feature lighting of the ventilation columns would be obscured or barely perceptible:

a. Viewpoint 1.2: View northwest and north from residences along Hopton Street on the opposite river bank
b. Viewpoint 2.2: View west from the Millennium Bridge (LVMF River Prospect)
c. Viewpoint 2.3: View northwest from the South Bank outside Tate Modern
d. Viewpoint 2.9: View east and southwest from the Thames Path opposite Somerset House
e. Viewpoint 2.10: View east from the Thames Path opposite Temple Place
f. Viewpoint 2.13: View south from the corner of Tudor Street and Carmelite Street

Residential

Viewpoint 1.1: View north from residences on the opposite river bank

11.6.38 Views from residences towards the site would be affected by the design of the new river wall, above ground structures and public realm. The new structures would form new components of the view in front of the existing Victorian and Edwardian building façades along Victoria Embankment. However, due to the commitment to a high quality design in keeping with the surrounding townscape (described in para. 11.2.6), including the use of natural stone for the river walls and using visually unobtrusive railings, the magnitude of change is considered to be low.

11.6.39 The low magnitude of change, assessed alongside the high sensitivity of the receptor would give rise to **minor adverse** effects.

11.6.40 There would be no change to the assessment during summer.

11.6.41 At night, the feature lighting of the ventilation columns would be visible in the view across the river. However, the lit columns would not represent a skyline feature and would be set in front of the brightly lit backdrop of lighting along Victoria Embankment. The columns would also not be set in front of the existing decoratively lit facades (which are further to the east near Blackfriars Bridge) or the festoon lighting along Victoria Embankment, which at present has a section missing where the columns would be located. Therefore, the magnitude of change is considered to be negligible.

11.6.42 The negligible magnitude of change, assessed alongside the high sensitivity of the receptor would give rise to a **negligible** effect at night.

Viewpoint 1.2: View northwest from residences along Hopton Street on the opposite river bank

11.6.43 Views from residences towards the Blackfriars Bridge Foreshore main site would be largely obscured by the arches of Blackfriars Bridge and Blackfriars railway bridge, although the new river wall and above ground structures would be intermittently visible. The Blackfriars Pier site would be visible as a fairly indistinct component of the wider river view, and one that is congruous with river use. Therefore, the magnitude of change is considered to be negligible.

11.6.44 The negligible magnitude of change, assessed alongside the high sensitivity of the receptor would result in a **negligible** effect.

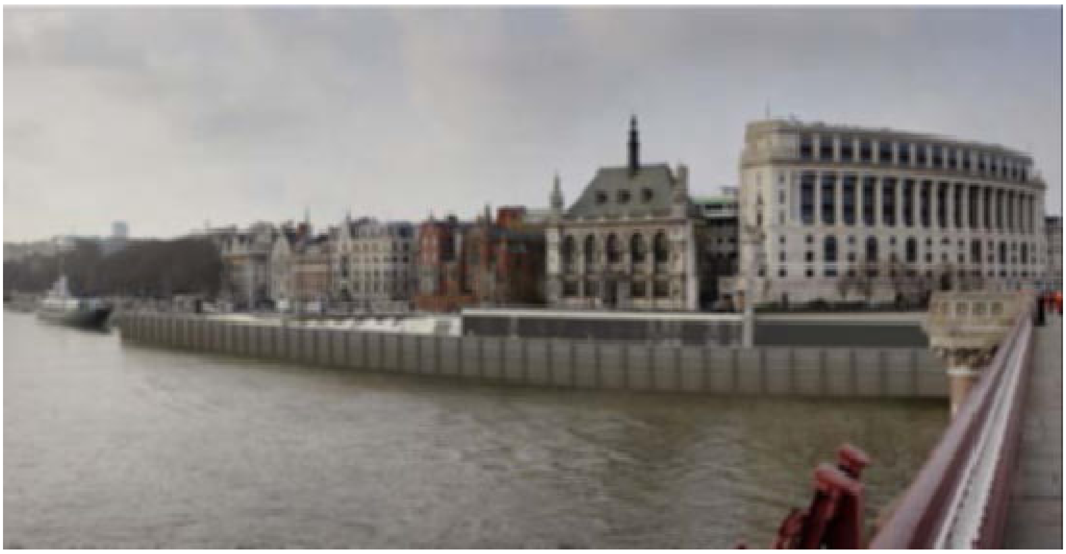
11.6.45 There would be no change to the assessment during summer.

Recreational

Viewpoint 2.1: View northwest from Blackfriars Bridge (LVMF River Prospect)

11.6.46 Views from this location would be affected by the design of the new river wall, above ground structures and public realm. The new structures would be form prominent components in the frame of view, set in front of Victoria Embankment, projecting into the river by approximately 35m. The view of the proposed development from this viewpoint is illustrated in Vol 18 Plate 11.6.1 below. A larger scale print of the photomontage, including the wider context and annotations, is provided in Vol 18 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 18 Plate 11.6.1 Viewpoint 2.1 – illustrative operational phase photomontage



Date taken: 17 March 2011. 50mm lens.

11.6.47 Because of the elevated position of the viewpoint, above the level of the site, the design of the public realm would be highly visible. Although the new structure would be highly prominent in the foreground of this view, the commitment to a high quality design in keeping with the character of the surrounding townscape (described in para. 11.2.6) would minimise the level of change perceived by visual receptors along Blackfriars Bridge. Therefore, the magnitude of change is considered to be low.

11.6.48 The low magnitude of change, assessed alongside the high sensitivity of the receptor would give rise to **minor adverse** effects.

11.6.49 There would be no change to the assessment during summer.

11.6.50 At night, the feature lighting of the ventilation columns would be visible in the view across the river. However, the lit columns would not represent a skyline feature and would be set in front of the brightly lit backdrop of lighting along Victoria Embankment. The columns would also not be set in front of the existing decoratively lit facades (which are further to the east near Blackfriars Bridge) or the festoon lighting along Victoria Embankment, which at present has a section missing where the columns would be located. The view of the proposed development from this viewpoint at night is illustrated in Vol 18 Plate 11.6.2 below. A larger scale print of the photomontage, including the wider context and annotations, is provided in Vol 18 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 18 Plate 11.6.2 Viewpoint 2.1 – illustrative night time operational phase photomontage

Date taken: 29 February 2012. 50mm lens.

11.6.51 Therefore, 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 give rise to a **negligible** effect at night.

11.6.53 The assessment of specific effects on the setting of the Grade II listed Blackfriars Bridge as a heritage asset is set out in Section 7 of this volume. The historic environment assessment identifies a moderate adverse effect due to the alteration within the immediate heritage setting of the asset.

Viewpoint 2.2: View west from the Millennium Bridge (LVMF River Prospect); and Viewpoint 2.3: View northwest from the South Bank outside Tate Modern

11.6.54 Views from these locations towards the Blackfriars Bridge Foreshore main site would be largely obscured by the arches of Blackfriars Bridge and Blackfriars railway bridge, although the new river wall and above ground structures would be intermittently visible. The Blackfriars Pier site would be visible as a fairly indistinct component of the wider river views, and one that is congruous with river use. Therefore, the magnitude of change is considered to be negligible. The view of the proposed development from Viewpoint 2.2 is illustrated in Vol 18 Plate 11.6.3 below. A larger scale print of the photomontage, including the wider context and annotations, is provided in Vol 18 Figure 11.6.3 (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 18 Plate 11.6.3 Viewpoint 2.2 – illustrative operational phase photomontage

Date taken: 28 August 2012. 50mm lens.

11.6.55 The negligible magnitude of change, assessed alongside the high sensitivity of these receptors would result in **negligible** effects.

11.6.56 There would be no change to the assessment during summer.

Viewpoint 2.4: View north from the South Bank outside Sea Containers House; and Viewpoint 2.6: View northeast from Gabriel's Wharf viewing platform (LVMF River Prospect)

11.6.57 Views from these locations would be affected by the design of the new river wall, above ground structures and public realm. The view of the proposed development from viewpoint 2.6 is illustrated in Vol 18 Plate 11.6.4 below. A larger scale print of the photomontage, including the wider context and annotations, is provided in Vol 18 Figure 11.6.4 (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 18 Plate 11.6.4 Viewpoint 2.6 – illustrative operational phase photomontage

Date taken: 17 March 2011. 50mm lens.

11.6.58 The new structures would form new components of the view across the river, with the majority of the foreshore structure sitting approximately at or below the existing river wall. The above ground structures, including the cluster of signature design ventilation columns at the western end of the site, would be barely perceptible and would sit below the skyline formed by the Victorian and Edwardian buildings behind the site. The commitment to a high quality design in keeping with the character of the surrounding townscape (described in para. 11.2.6) would further reduce visibility of the site. Therefore, the magnitude of change is considered to be low.

11.6.59 The low magnitude of change assessed alongside the high sensitivity of these receptors would give rise to **minor adverse** effects.

11.6.60 There would be no change to the assessment during summer.

11.6.61 At night, the feature lighting of the ventilation columns would be visible in the views across the river. However, the lit columns would not represent a skyline feature and would be set in front of the brightly lit backdrop of lighting along Victoria Embankment. The columns would also not be set in front of the existing decoratively lit facades (which are further to the east near Blackfriars Bridge) or the festoon lighting along Victoria Embankment, which at present has a section missing where the columns would be located. The view of the proposed development from viewpoint 2.6 at night is illustrated in Vol 18 Plate 11.6.5 below. A larger scale print of the photomontage, including the wider context and annotations, is provided in Vol 18 Figure 11.6.5 (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 18 Plate 11.6.5 Viewpoint 2.6 – illustrative night time operational phase photomontage

Date taken: 29 February 2012. 50mm lens.

11.6.62 Therefore, the magnitude of change is considered to be negligible.

11.6.63 The negligible magnitude of change, assessed alongside the high sensitivity of these receptors would give rise to a **negligible** effect at night.

Viewpoint 2.7: View northeast from Waterloo Bridge (LVMF River Prospect); and Viewpoint 2.8: View east from the northern end of Waterloo Bridge

11.6.64 The background of views from these locations would be affected to a limited extent by the design of the new river wall, above ground structures and public realm. The new structures would form fairly indistinct components in the background of the views, set in front of the existing Victorian and Edwardian building façades along Victoria Embankment. The foreshore structure would sit approximately at or below the existing height of the river wall and the above ground structures would be barely perceptible below the existing skyline. The commitment to a high quality design in keeping with the character of the surrounding townscape (described in para. 11.2.6) would further reduce visibility of the site. The view of the proposed development from viewpoints 2.7 and 2.8 is illustrated in Vol 18 Plate 11.6.6 and Vol 18 Plate 11.6.7 below. A larger scale print of the photomontages, including the wider context and annotations, is provided in Vol 18 Figure 11.6.6 and Vol 18 Figure 11.6.7 (see separate volume of figures). The layout of the proposed development illustrated in these photomontages 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 18 Plate 11.6.6 Viewpoint 2.7 – illustrative operational phase photomontage

Date taken: 28 August 2012. 50mm lens.

Vol 18 Plate 11.6.7 Viewpoint 2.8 – illustrative operational phase photomontage

Date taken: 28 August 2012. 50mm lens.

11.6.65 Therefore, the magnitude of change is considered to be negligible.

11.6.66 The negligible magnitude of change assessed alongside the high sensitivity of these receptors would give rise to **negligible** effects.

11.6.67 There would be no change to the assessment during summer.

11.6.68 At night, the feature lighting of the ventilation columns would be visible in the background of the views across the river, partially obscured by the 'President' vessel. However, the lit columns would not represent a skyline feature and would be set in front of the brightly lit backdrop of lighting along Victoria Embankment. The columns would also not be set in front of the existing decoratively lit facades (which are further to the east near Blackfriars Bridge) or the festoon lighting along Victoria Embankment, which at present has a section missing where the columns would be located. Therefore, the magnitude of change is considered to be negligible.

11.6.69 The negligible magnitude of change, assessed alongside the high sensitivity of these receptors would give rise to a **negligible** effect at night.

Viewpoint 2.9: View east and southwest from the Thames Path opposite Somerset House; and Viewpoint 2.10: View east and southwest from the Thames Path opposite Temple Place

11.6.70 Views from these locations towards the Blackfriars Bridge Foreshore site would be partially screened by the avenue of London plane trees and permanent moorings along Victoria Embankment. The majority of the views of the river and opposite river bank would be largely unaltered. The new river wall and above ground structures would form a fairly indistinct component of the wider river views, beyond the trees and moorings, particularly given the commitment to a high quality design in keeping with the character of the surrounding townscape (described in para. 11.2.6).

11.6.71 The components of the proposed works at the Victoria Embankment Foreshore site would be barely perceptible from these locations.

11.6.72 Therefore, the magnitude of change is considered to be negligible.

11.6.73 The negligible magnitude of change, assessed alongside the high sensitivity of these receptors would give rise to **negligible** effects.

11.6.74 During summer, mature trees in the foreground of the view would further obscure views towards the site. Therefore, the magnitude of change would remain **negligible**.

Viewpoint 2.11: View east from the Thames Path opposite Milford Lane; and Viewpoint 2.12: View east from the Thames Path opposite Inner Temple Gardens

11.6.75 Views from these locations towards the Blackfriars Bridge Foreshore site would be partially screened by the avenue of London plane trees and the reinstatement of the ‘President’ vessel along Victoria Embankment. The view of the proposed development from viewpoint 2.12 is illustrated in Vol 18 Plate 11.6.8 below. A larger scale print of the photomontage, including the wider context and annotations, is provided in Vol 18 Figure 11.6.8 (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 18 Plate 11.6.8 Viewpoint 2.12 – illustrative operational phase photomontage

Date taken: 17 March 2011. 50mm lens.

11.6.76 Most views of the river and opposite river bank would be largely unaltered. The new river wall and above ground structures would form a new component of the immediate river views, beyond the trees and moorings. However, due to the commitment to a high quality design in keeping with the character of the surrounding townscape (described in para. 11.2.6), the magnitude of change is considered to be low. The low magnitude of change, assessed alongside the high sensitivity of these receptors would give rise to **minor adverse** effects.

11.6.77 There would be no change to the assessment during summer.

11.6.78 At night, the feature lighting of the ventilation columns would be intermittently visible in the view down the river, beyond the jetties and moored 'President' vessel in the foreground of the view. The lit columns would form a new feature alongside the formal lamp standards along Victoria Embankment, and would be set in front of lighting along Blackfriars Bridge. However, the lit columns would be lower in height than the lit masts of the 'President' vessel. Therefore, the magnitude of change is considered to be negligible.

11.6.79 The negligible magnitude of change, assessed alongside the high sensitivity of these receptors would give rise to a **negligible** effect at night.

Viewpoint 2.14: View south from the corner of Tudor Street and Carmelite Street

11.6.80 Views from this location down to the River Thames would be affected to a limited extent by the foreshore structure that would project into the river. The restoration of components characteristic of the existing view, including the river wall and listed lamp standards would minimise the change to this view. The river would remain visible beyond the foreshore structure and the above ground structures would be located outside the field of view, screened by buildings along Carmelite Street. Therefore, the magnitude of change on this view would be negligible.

11.6.81 The negligible magnitude of change, assessed alongside the high sensitivity of the receptor would result in a **negligible** effect.

11.6.82 During summer, trees planted as part of the scheme would filter views of the foreshore structure. Therefore, the magnitude of change would remain **negligible**.

Employment

Viewpoint 4.1: View south from the office buildings along Victoria Embankment

11.6.83 Views for workers from this location towards the site would be affected by the foreground visibility of the improved Thames Path and the high quality area of public realm on the foreshore structure beyond. From ground level, views would be improved due to the removal of existing structures which detract from the current view, replaced by a high quality public realm. Views of the foreshore structure beyond would be partially obscured by Victoria Embankment, which is elevated at this location in the approach to Blackfriars Bridge. The signature design ventilation columns would form a fairly indistinct component in the background of the view. From higher levels, there would be more direct views of the new high quality area public realm in the foreground, although these would be set within the context of the restored historic river wall line and the river. Furthermore, the commitment to a high quality design for the public realm and above ground structures, and the planting of mature London plane trees along Victoria Embankment (filtering visibility of the new structure) would minimise the level of change to this view. Therefore, the magnitude of change is considered to be medium.

11.6.84 The medium magnitude of change, assessed alongside the low sensitivity of the receptor, would result in **minor beneficial** effects.

11.6.85 During summer, wider views of the foreshore structure would be partially screened by tree planting along Victoria Embankment. However, the improvements to the Thames Path in the foreground of the view would remain visible. Therefore, the magnitude of change is considered to remain medium, giving rise to **minor beneficial** effects during summer.

11.6.86 At night, the feature lighting of the ventilation columns would be visible in the background of the view across the river set beyond fairly bright levels of light along Victoria Embankment. The lit columns would not represent a skyline feature and would be barely perceptible against the wider levels of light within the field of view. Therefore, the magnitude of change is considered to be negligible.

11.6.87 The negligible magnitude of change, assessed alongside the low sensitivity of the receptor would give rise to a **negligible** effect at night.

Visual effects – sensitivity test for programme delay

11.6.88 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. 11.6.36 to 11.6.87). 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. 11.4.86 to 11.4.163.

Operational effects Year 15

11.6.89 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 (including the newly planted London plane trees) 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

11.7.1 As detailed in the site development schedule (Vol 18 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 development and *CoCP* of relevance to the townscape and visual assessment are summarised in Section 11.2. No further mitigation during construction is possible due to the highly visible nature of the construction activities.

11.8.2 A process of iterative design and assessment has been employed to reduce adverse effects during operation. No further mitigation is possible due to the highly sensitive nature of the townscape and highly visible nature of the proposed development.

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 for construction 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 for operation are presented in Section 11.10.

11.10 Assessment summary

Vol 18 Table 11.10.1 Townscape – summary of construction assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Blackfriars Bridge Foreshore main site	Change to character due to site clearance, construction of the site cofferdam and intensity of construction activity.	Major adverse	No mitigation possible	Major adverse
Blackfriars Pier site	Change to character due to site clearance and construction of the pier.	Minor adverse	None	Minor adverse
River Thames – Central London Reach TCA	Change to setting due to high levels of construction activity in this reach of the river at the Blackfriars Bridge Foreshore site and the presence of wider construction activity at Victoria Embankment Foreshore.	Major adverse	No mitigation possible	Major adverse
River Thames – Victoria Embankment Gardens and Jubilee Gardens Reach TCA	Marginal change to setting of the northern section of the character area due to construction activity at the Blackfriars Bridge Foreshore site, partially screened by Waterloo Bridge. Change to setting of the southern section of the character area due to high levels of construction activity at the Victoria Embankment Foreshore site.	Major adverse	No mitigation possible	Major adverse
Whitefriars Conservation Area TCA	Change to immediate riverside setting due to site hoardings, welfare facilities, construction activity and construction plant at the Blackfriars Bridge Foreshore site. Limited change to wider setting due to the presence of tall construction plant and cranes at the Victoria Embankment Foreshore site.	Major adverse	No mitigation possible	Major adverse

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
City of London Mixed Use TCA	Change to a small part of the riverside setting due to construction activity at the Blackfriars Bridge Foreshore main site and limited changes to the wider riverside setting due to construction at the Blackfriars Pier site.	Minor adverse	None	Minor adverse
Tate Modern TCA	Marginal change to setting due to construction activity at the Blackfriars Bridge Foreshore main site, partially screened by Blackfriars Bridge and Blackfriars railway bridge, and limited change to setting arising from construction activity at the Blackfriars Pier site.	Minor adverse	None	Minor adverse
Southwark Mixed Use TCA	Change to a small part of the riverside setting arising from construction activity at the Blackfriars Bridge Foreshore main site, and changes to the remainder of the riverside setting due to construction activity at the Blackfriars Pier site.	Minor adverse	None	Minor adverse
South Bank Conservation Area TCA	Change to riverside setting of the northern section of the character area due to construction activity at the Blackfriars Bridge Foreshore site and to the London Eye section of the area due to construction at the Victoria Embankment Foreshore site.	Major adverse	No mitigation possible	Major adverse
Victoria Embankment Administrative TCA	Change to wider riverside setting of the northern section of the character area due to construction activity at Blackfriars Bridge Foreshore. Change to immediate riverside setting of the southern section of the area due to construction at the Victoria Embankment Foreshore site.	Moderate adverse	No mitigation possible	Moderate adverse
Temples Conservation Area TCA	Change to immediate riverside setting due to site hoardings, welfare facilities, construction activity and	Major adverse	No mitigation	Major adverse

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
	construction plant at the Blackfriars Bridge Foreshore site. The wider setting of Inner Temple would be unaffected. Limited change to wider setting due to the presence of tall construction plant and cranes at the Victoria Embankment Foreshore site.		possible	

Vol 18 Table 11.10.2 Visual – summary of construction assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Designated Views				
London View Management - Linear View 8A.1	No significant effects.	Negligible	None	Negligible
London View Management – Linear View 9A.1	Background visibility of cranes.	Negligible	None	Negligible
Residential				
Viewpoint 1.1: View north from residences on the opposite river bank	Visibility of the temporary cofferdam, welfare facilities, construction activity and construction plant.	Major adverse	No mitigation possible	Major adverse
Viewpoint 1.2: View northwest and north from residences along Hopton Street on the opposite river bank	Visibility of construction activity at the Blackfriars Pier site. Visibility of tall construction plant and cranes at the main site, partially screened by Blackfriars Bridge and Blackfriars railway bridge.	Minor adverse	None	Minor adverse
Recreational				
Viewpoint 2.1: View northwest from Blackfriars Bridge (LVMF River Prospect)	Visibility of the temporary cofferdam, construction activity and construction plant.	Major adverse	No mitigation possible	Major adverse
Viewpoint 2.2: View west from Millennium Bridge (LVMF River Prospect)	Visibility of construction activity at the Blackfriars Pier site. Visibility of tall construction plant and cranes at the main site, partially screened by Blackfriars Bridge and Blackfriars	Minor adverse	None	Minor adverse

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
	railway bridge.			
Viewpoint 2.3: View northwest from the South Bank outside Tate Modern	Visibility of construction activity at the Blackfriars Pier site. Visibility of tall construction plant and cranes at the main site, partially screened by Blackfriars Bridge and Blackfriars railway bridge.	Minor adverse	None	Minor adverse
Viewpoint 2.4: View north from the South Bank outside Sea Containers House	Visibility of the temporary cofferdam, welfare facilities, construction activity and construction plant.	Major adverse	No mitigation possible	Major adverse
Viewpoint 2.5: View northeast from Bernie Spain Gardens	Background visibility of the temporary cofferdam, construction activity and construction plant, partially screened by intervening buildings and planting.	Minor adverse	None	Minor adverse
Viewpoint 2.6: View northeast from Gabriel's Wharf viewing platform (LVMF River Prospect)	Visibility of the temporary cofferdam, welfare facilities, construction activity and construction plant.	Major adverse	No mitigation possible	Major adverse
Viewpoint 2.7: View northeast from Waterloo Bridge (LVMF River Prospect)	Background visibility of the temporary cofferdam, welfare facilities, construction activity and construction plant.	Moderate adverse	No mitigation possible	Moderate adverse
Viewpoint 2.8: View east from the northern end of Waterloo Bridge	Background visibility of the temporary cofferdam, welfare facilities, construction activity and construction plant.	Moderate adverse	No mitigation possible	Moderate adverse
Viewpoint 2.9: View east and southwest from the Thames Path opposite Somerset House	Middle ground visibility of the temporary cofferdam at the Blackfriars Bridge Foreshore site, partially screened by	Minor adverse	None	Minor adverse

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
	mature trees and permanent river moorings. Intermittent visibility of tall construction plant and cranes at Victoria Embankment Foreshore.			
Viewpoint 2.10: View east and southwest from the Thames Path opposite Temple Place	Middle ground visibility of the temporary cofferdam at the Blackfriars Bridge Foreshore site, partially screened by mature trees and permanent river moorings. Intermittent visibility of tall construction plant and cranes at Victoria Embankment Foreshore.	Minor adverse	None	Minor adverse
Viewpoint 2.11: View east from the Thames Path opposite Milford Lane	Middle ground visibility of the temporary cofferdam at the Blackfriars Bridge Foreshore site, partially screened by mature trees and permanent river moorings.	Minor adverse	None	Minor adverse
Viewpoint 2.12: View east from the Thames Path opposite Inner Temple Gardens	Foreground visibility of site hoardings, welfare facilities, construction activity and construction plant, partially obscured by the ‘President’ vessel.	Moderate adverse	No mitigation possible	Moderate adverse
Viewpoint 2.13: View south from Temple Avenue	Glimpsed visibility of site hoardings, construction activity and cranes.	Minor adverse	None	Minor adverse
Viewpoint 2.14: View south from the corner of Tudor Street and Carmelite Street	Glimpsed visibility of site hoardings, construction activity and cranes.	Minor adverse	None	Minor adverse

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Employment and other institutions				
Viewpoint 4.1: View south from the office buildings along Victoria Embankment	Foreground visibility of site hoardings, welfare facilities and construction plant.	Moderate adverse	No mitigation possible	Moderate adverse

Vol 18 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
Blackfriars Bridge Foreshore main site	Change in character through the introduction of a new area of public realm projecting into the river although sympathetic to the wider townscape character. The works would also constitute an improvement to the localised character along the Thames Path.	Minor adverse	None	Minor adverse
Blackfriars Pier site	Slight change in character due to the installation of the pier structure, set in close proximity to similar structures.	Negligible	None	Negligible
River Thames – Central London Reach TCA	Change to setting through the introduction of a new area of public realm projecting into the river at Blackfriars Bridge Foreshore and, in the wider setting, Victoria Embankment Foreshore. However, the design of both sites would be sympathetic to the wider townscape character.	Minor adverse	None	Minor adverse
Whitefriars Conservation Area TCA	Improvement to immediate riverside setting through the removal of existing structures which detract from the setting of this area and the creation of a new area of high quality public realm, albeit within the river corridor.	Minor beneficial	None	Minor beneficial
Southwark Mixed Use TCA	Change to a small part of the riverside setting through the introduction of a new area of public realm projecting into the river at the Blackfriars Bridge Foreshore main site. Minimal change to wider riverside setting due to the new pier east of Blackfriars railway bridge	Negligible	None	Negligible
South Bank	Change to wider riverside setting of the northern section of	Minor	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. 11.6.14) are not included in the summary table

Receptor[ii]	Effect	Significance of effect	Mitigation	Significance of residual effect
Conservation Area TCA	this character area through the introduction of a new area of public realm projecting into the river at the Blackfriars Bridge Foreshore site. Change to immediate riverside setting of the London Eye section of the area due to the foreshore structure at the Victoria Embankment Foreshore site.	adverse		
Temples Conservation Area TCA	Change to riverside setting through the introduction of new public realm and above ground structures in an area previously part of the river.	Minor adverse	None	Minor adverse

Vol 18 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
Residential				
Viewpoint 1.1: View north from residences on the opposite river bank	Visibility of the new river wall, above ground structures and public realm projecting into a sensitive stretch of river.	Winter – Minor adverse	Winter – None	Winter – Minor adverse
		Summer – Minor adverse	Summer – None	Summer – Minor adverse
	At night, visibility of the lit ventilation columns against a brightly lit backdrop.	Negligible	None	Negligible
Viewpoint 1.2: View northwest from residences along Hopton Street on the opposite river bank	Intermittent visibility of the new river wall and above ground structures at the Blackfriars Bridge Foreshore main site. Visibility of the Blackfriars Pier site.	Winter – Negligible	Winter – None	Winter – Negligible
		Summer – Negligible	Summer – None	Summer – Negligible
Recreational				
Viewpoint 2.1: View northwest from Blackfriars Bridge (LVMF River Prospect)	Visibility of the new river wall, above ground structures and public realm projecting into a sensitive stretch of river.	Winter – Minor adverse	Winter – None	Winter – Minor adverse
		Summer – Minor adverse	Summer – None	Summer – Minor adverse
	At night, visibility of the lit ventilation columns against a brightly lit	Negligible	None	Negligible

[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. 11.6.36) are not included in the summary table

Receptor[iv]	**Effect**	**Significance of effect**	**Mitigation**	**Significance of residual effect**
	backdrop.			
Viewpoint 2.2: View west from Millennium Bridge (LVMF River Prospect)	Intermittent visibility of the new river wall and above ground structures at the Blackfriars Bridge Foreshore main site. Visibility of the Blackfriars Pier site.	Winter – Negligible	Winter – None	Winter – Negligible
		Summer – Negligible	Summer – None	Summer – Negligible
Viewpoint 2.3: View northwest from the South Bank outside Tate Modern	Intermittent visibility of the new river wall and above ground structures at the Blackfriars Bridge Foreshore main site. Visibility of the Blackfriars Pier site.	Winter – Negligible	Winter – None	Winter – Negligible
		Summer – Negligible	Summer – None	Summer – Negligible
Viewpoint 2.4: View north from the South Bank outside Sea Containers House	Visibility of the new river wall, above ground structures and public realm projecting into a sensitive stretch of river.	Winter – Minor adverse	Winter – None	Winter – Minor adverse
		Summer – Minor adverse	Summer – None	Summer – Minor adverse
	At night, visibility of the lit ventilation columns against a brightly lit backdrop.	Negligible	None	Negligible
Viewpoint 2.6: View northeast from Gabriel's Wharf viewing platform (LVMF River Prospect)	Visibility of the new river wall, above ground structures and public realm projecting into a sensitive stretch of river.	Winter – Minor adverse	Winter – None	Winter – Minor adverse
		Summer – Minor adverse	Summer – None	Summer – Minor adverse
	At night, visibility of the lit ventilation columns against a brightly lit backdrop.	Negligible	None	Negligible

Receptor[iv]	Effect	Significance of effect	Mitigation	Significance of residual effect
Viewpoint 2.7: View northeast from Waterloo Bridge	Background visibility of the new river wall, above ground structures and public realm, partially screened by permanent moorings.	Winter – Negligible	Winter – None	Winter – Negligible
		Summer – Negligible	Summer – None	Summer – Negligible
	At night, background visibility of the lit ventilation columns against a brightly lit backdrop.	Negligible	None	Negligible
Viewpoint 2.8: View east from the northern end of Waterloo Bridge	Background visibility of the new river wall, above ground structures and public realm, partially screened by permanent moorings.	Winter – Negligible	Winter – None	Winter – Negligible
		Summer – Negligible	Summer – None	Summer – Negligible
	At night, background visibility of the lit ventilation columns against a brightly lit backdrop.	Negligible	None	Negligible
Viewpoint 2.9: View east and southwest from the Thames Path opposite Somerset House	Visibility of the new river wall, above ground structures and public realm at the Blackfriars Bridge Foreshore site, largely screened by intervening tree planting and permanent moorings.	Winter – Negligible	Winter – None	Winter – Negligible
		Summer – Negligible	Summer – None	Summer – Negligible
Viewpoint 2.10: View east and southwest from the Thames Path opposite Temple Place	Visibility of the new river wall, above ground structures and public realm at the Blackfriars Bridge Foreshore site, largely screened by intervening tree planting and permanent moorings.	Winter – Negligible	Winter – None	Winter – Negligible
		Summer – Negligible	Summer – None	Summer – Negligible

Receptor[iv]	Effect	Significance of effect	Mitigation	Significance of residual effect
Viewpoint 2.11: View east from the Thames Path opposite Milford Lane	Visibility of the new river wall, above ground structures and public realm, partially screened by intervening tree planting and the ‘President.	Winter – Minor adverse	Winter – None	Winter – Minor adverse
		Summer – Minor adverse	Summer – None	Summer – Minor adverse
	At night, visibility of the lit ventilation columns amongst lighting on Victoria Embankment and the ‘President’ vessel.	Negligible	None	Negligible
Viewpoint 2.12: View east from the Thames Path opposite Inner Temple Gardens	Visibility of the new river wall, above ground structures and public realm, partially screened by intervening tree planting and the ‘President.	Winter – Minor adverse	Winter – None	Winter – Minor adverse
		Summer – Minor adverse	Summer – None	Summer – Minor adverse
	At night, visibility of the lit ventilation columns amongst lighting on Victoria Embankment and the ‘President’ vessel.	Negligible	None	Negligible
Viewpoint 2.14: View south from the corner of Tudor Street and Carmelite Street	Limited visibility of the foreshore structure.	Winter – Negligible	Winter – None	Winter – Negligible
		Summer – Negligible	Summer – None	Summer – Negligible
Employment				
Viewpoint 4.1: View south from the	From ground level, visibility of the	Winter –	Winter –	Winter –

Receptor[iv]	Effect	Significance of effect	Mitigation	Significance of residual effect
office buildings along Victoria Embankment	improved Thames Path by virtue of the existing detracting structures having been removed during construction and replaced with high quality public realm. From upper storeys, visibility of the high quality public realm and above ground structures, albeit projecting into a sensitive stretch of the river.	Minor beneficial	None	Minor beneficial
		Summer – Minor beneficial	Summer – None	Summer – Minor beneficial
	Background visibility of lit ventilation columns beyond bright levels of light along Victoria Embankment.	Negligible	None	Negligible

References

[1] Department of Environment, Food and Rural Affairs (Defra)*. National Policy Statement for Waste Water* (2012)..

[2] British Standards*. BS5837:Trees in Relation to Construction – Recommendations* (2012).

[3] Mayor of London. *Revised Supplementary Planning Guidance – London View Management Framework* (July 2012).

[4] City of London Corporation. *LDF Core Strategy* (September 2010).

[5] LB of Southwark. *LDF Core Strategy* (April 2011).

[6] LB of Lambeth. *LDF Core Strategy* (January 2011).

[7] Westminster City Council. *LDF Core Strategy* (January 2011).

[8] City of London Corporation. *Whitefriars Conservation Area character summary* (no date).

[9] City of London Corporation. *Temples Conservation Area character summary* (2007).

[10] City of London Corporation. *Temples Conservation Area: Management Strategy* (no date).

[11] LB of Lambeth. *South Bank Conservation Area profile* (September 2007).

[12] Westminster City Council. *Conservation Area Information Leaflets* (May 2004).

[13] Defra. (2012). See citation above.

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.18**

Volume 18 Blackfriars Bridge Foreshore site assessment

Section 12: Transport

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

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Thames Tideway Tunnel

Environmental Statement

Volume 18: Blackfriars Bridge 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 Blackfriars Bridge 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. coach parking and loading bays

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 residents at Kings Bench Walk, users of nearby commercial properties, users of Inner Temple Gardens and users of the President vessel.

12.1.4 The operation of the Blackfriars Bridge Foreshore site has the potential to affect coach parking, pedestrian routes and highway layout and operation and therefore effects on these are considered within the operational assessment.

12.1.5 The assessment of transport effects 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 Blackfriars Bridge Foreshore site. The *Transport Assessment* will accompany the 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 18 Blackfriars Bridge 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 of this volume.

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 Blackfriars Bridge Foreshore site comprises two sites – the main site and the Blackfriars Pier site to accommodate the relocation of Blackfriars Millennium Pier.

12.2.3 The main site would be located in the foreshore of the River Thames. In order to provide working areas, this site would also occupy part of the riverside footway, from Paul's Walk adjacent to Blackfriars Bridge to Victoria Embankment (A3211), opposite Temple Avenue.

12.2.4 Throughout construction (all phases), the Thames Path route along the riverside footway would be diverted. This diversion would use the existing stairs from Paul's Walk to Blackfriars Bridge (A201), together with a new lift to divert pedestrians to Blackfriars Bridge Road (A201) where they would use the at-grade crossing points to access the northern footway of Victoria Embankment (A3211). It is possible that the existing stairs would need to be reconfigured to accommodate the lift. This route would provide an east-west route for users of the Thames Path and interconnection between the relocated Blackfriars Millennium Pier and Blackfriars Station.

12.2.5 During construction (all phases) the pedestrian crossing at the junction of Victoria Embankment (A3211) and Temple Avenue would be used by pedestrians to cross Victoria Embankment (A3211) to get back to the Thames Path on the foreshore footway to the west of the site.

12.2.6 Blackfriars Millennium Pier would be permanently relocated to the east side of Blackfriars rail Bridge prior to the commencement of works at the main site. Pedestrian access to the pier would be via the existing staircase (possibly modified) or new lift as detailed in paragraph 12.2.4 for the Thames Path pedestrian diversion route. Additionally, to facilitate construction works, the President, a permanently moored restaurant boat, would be temporarily relocated at Chrysanthemum Pier to the west of the main site and would return to its original position following completion of the main site construction works.

12.2.7 In Phases 1 and 2 the site access for construction vehicles would be from the westbound ramp leading down from Blackfriars Bridge (A201). During this time the traffic lane would be narrowed during specific construction activities to enable access and egress of site vehicles. A minimum lane width of 3.25m would be retained through both phases.

12.2.8 In Phase 3 the westbound ramp leading down from Blackfriars Bridge (A201) would be closed when all construction vehicles would use the westbound carriageway of Blackfriars underpass to access the site.

12.2.9 During Phase 3, general traffic and buses unable to use the westbound ramp would be diverted either north and west via Fleet Street and Arundel Street or south and east via Southwark Street (A3200) and Southwark

Bridge (A300) and along Upper Thames Street (A3211) to access Victoria Embankment (A3211).

12.2.10 During construction it is anticipated that the elements listed under para. 12.1.2 above may be affected as a result of the additional construction traffic associated with the Blackfriars Bridge Foreshore site and other Thames Tideway Tunnel construction sites with routes along Victoria Embankment (A3211), vehicle and pedestrian diversions along Victoria Embankment (A3211), the temporary suspension of coach parking and loading bays on the westbound ramp of Victoria Embankment (A3211) and the closure of the westbound ramp (Phase 3 only).

12.2.11 Details of the peak year of construction, anticipated lorry and barge movements and the activities which would generate these movements are provided in Vol 18 Table 12.2.1.

Vol 18 Table 12.2.1 Transport – construction details

Description	Assumption
Assumed peak period of construction lorry movements	Site Year 2 of construction
Assumed average peak daily construction lorry vehicle movements (in peak month of Site Year 2 of construction)	92 movements per day (46 vehicle trips)
Assumed peak period of construction barge movements	Site Year 4 of construction
Assumed average peak daily construction barge movements (in peak month of Site Year 4 of construction)	6 movements per day (3 barge trips)
Typical types of lorry requiring access (comprising rigid-bodied, flatbed and articulated vehicles)	Excavated material lorries Ready mix concrete lorries Plant and equipment deliveries Imported fill lorries Office/general delivery lorries Steel reinforcement / rebar lorries Temporary construction material lorries including formwork and falsework

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

12.2.12 During construction cofferdam fill (both import and export) and excavated material from the shaft and other excavations would be transported by barge. For the *Transport Assessment* it has been assumed that 90% of these materials would be taken by river. This allows for periods that the river is unavailable and material unsuitable for river transport. All other material would be transported by road.

12.2.13 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). During a period of extended hours working there would be days when work would take place up to 22.00 for large concrete pours for diaphragm wall construction. Outside this period it would only be in exceptional circumstances that HGV and abnormal load movements could occur up to 22:00 on weekdays and later at night on agreement with the City of London Corporation.

Construction traffic routing

12.2.14 The access plan and highway layout during construction plans (see separate volume of figures – Section 1) present the highway layout during construction.

12.2.15 The Blackfriars Bridge Foreshore site would be located on the Transport for London Road Network (TLRN) on Victoria Embankment (A3211), west of Blackfriars Bridge (A201) and the Blackfriars underpass.

12.2.16 Construction vehicles would use the TLRN to access this site in all construction phases.

12.2.17 Arriving construction vehicles during Phases 1 and 2 would come through the signal junction of Blackfriars Bridge Road (A201), New Bridge Street (A201) and Victoria Embankment (A3211) to the east of the site and would access the site via the westbound ramp leading down from Blackfriars Bridge. Construction vehicles would access the site directly from the ramp. Access to the site for all construction vehicles would be situated on the ramp and therefore would not be accessible directly from the Victoria Embankment (A3211) during Phases 1 and 2.

12.2.18 During Phase 3 of construction the westbound ramp would be closed to facilitate construction works at the main site. Arriving construction vehicles would therefore approach the site from the westbound carriageway of Upper Thames Street (A3211) and depart westbound on Victoria Embankment (A3211). Traffic management would be required on Upper Thames Street (westbound) leaving Blackfriars Underpass, to facilitate safe exit of construction vehicles onto Victoria Embankment (A3211).

12.2.19 Departing construction vehicles, in all phases, would head west along Victoria Embankment (A3211). Vehicles would cross the River Thames at Westminster Bridge (A302) to continue south along the A3036 towards Lambeth, southeast towards Southwark along the A3200 or southeast on the A302 towards Elephant and Castle.

12.2.20 Vol 18 Figure 12.2.1 (see separate volume of figures) shows the construction traffic routes for access to/from the Blackfriars Bridge

Foreshore site. Construction routes have been discussed with both Transport for London (TfL) and the Local Highway Authority (LHA), City of London Corporation, for the purposes of the assessment.

12.2.21 This construction vehicle routing may overlap for a period with the routes used by construction vehicles associated with the Victoria Embankment Foreshore site to the west along Victoria Embankment (A3211). This is taken into account as part of this assessment. Section 12 of Volume 3 discusses the combined construction traffic effects of both the Blackfriars Bridge Foreshore and Victoria Embankment Foreshore sites.

Construction workers

12.2.22 The construction site is expected to require a maximum workforce of approximately 70 workers at any one time. The number and type of workers is shown in Vol 18 Table 12.2.2.

Vol 18 Table 12.2.2 Transport – maximum estimated construction worker numbers

Contractor		Client
Staff[a]	**Labour[b]**	**Staff[c]**
08:00-18:00	**08:00-18:00**	**08:00-18:00**
30	30	10

[a]Staff Contractor – engineering and support staff to direct and to project manage the engineering work and site.
[b]Labour – those working on site doing engineering, construction and manual work.
[c]Staff Client – engineering and support staff managing the project and supervising the Contractor.

12.2.23 At the Blackfriars Bridge 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 18 Table 12.5.1.

Code of Construction Practice

12.2.24 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 *Code of Construction Practice (CoCP) Part A* (Section 5) to reduce transport issues 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.

12.2.25 In addition to the general measures within the *CoCP Part A*, the following measures have been incorporated into the *CoCP Part B* (Section 5) relating to the Blackfriars Bridge Foreshore site:

a. site access for construction is to be from the new entrance from the westbound ramp leading down from Blackfriars Bridge, apart from the period where the Low Level No. 1 interception chamber works are undertaken. During this construction phase access would be from Blackfriars underpass

b. lorry arrivals would be strictly controlled and co-ordinated to set times to ensure that no lorries queue outside the site

c. the westbound ramp can only take standard HGVs and not abnormal loads

d. the area shown for temporary traffic lane closure at the end of the down ramp is to be used only when required. After use, the area would be restored to highway use. Given notice by the City of London Corporation and TfL for traffic reasons, the area would be restored to traffic as soon as practical after notice

e. the minimum width of traffic lane to be retained on the westbound ramp would be 3.25m

f. existing coach parking and loading bay on the westbound ramp and Victoria Embankment (A3211) would be suspended

g. the duration of works effecting traffic lanes including the ramp closure would be minimised

h. the new pier is to be in place before the closure of the existing pier

i. access to the existing and relocated pier to be maintained for both pedestrians and services. Liaison with London River Services (Transport for London) is required

j. a detailed navigational risk assessment is required as part of the River Works Licence to confirm that the arrangements for river transport from the works are safe and acceptable to the PLA.

k. the diversion of the Thames Path is to be clearly signed

l. coordination is required with both the City of London Corporation and TfL on the requirements of amended pedestrian routes to the relocated Blackfriars Pier. This includes notices, pamphlets, guides and signage to the public

12.2.26 Based on current travel planning guidance including TfL's 'Travel Planning for new development in London (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[3]; this will accompany the application. The *Draft Project Framework Travel Plan* addresses project-wide travel planning measures, including the need for a 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 Blackfriars Bridge Foreshore site

b. a mode split established for the Blackfriars Bridge Foreshore site construction workers to establish and monitor travel patterns

c. site-specific targets and interim targets based on the mode share which would link to objectives based on local, regional and national policy

d. a nominated person with assigned responsibility for managing the *Travel Plan* monitoring and action plans specifically for this site.

Other measures during construction

12.2.27 Embedded design measures which are not outlined in the *CoCP* but are of relevance to the *Transport Assessment* at the Blackfriars Bridge Foreshore site include the provision of diversion routes for pedestrians for the duration of the construction works, including provision of a new lift to enable step-free pedestrian access from Paul's Walk to Blackfriars Bridge (A201).

Operation

Maintenance activity

12.2.28 During operation, maintenance vehicles would enter the site (main site) from the westbound ramp from the Blackfriars Bridge (A201) / New Bridge Street (A201) junction, as set out in the Blackfriars Bridge Foreshore design principles. Access would be required for a light commercial vehicle on a three to six monthly maintenance schedule. Additionally there would be more substantive 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.

Relocation of Blackfriars Millennium Pier

12.2.29 It is proposed that Blackfriars Millennium Pier would remain in its relocated position to the east of Blackfriars rail Bridge during the operational phase. It is therefore necessary to consider the effects on river services and usage in addition to the elements which could be affected by maintenance activity, set out in para. 12.1.2.

12.3 Assessment methodology

Engagement

12.3.1 Volume 2 documents the overall engagement which has been undertaken in preparing the ES. Specific comments relevant to this site for the assessment of traffic and transport are presented in Vol 18 Table 12.3.1.

12.3.2 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 18 Table 12.3.1 Transport – stakeholder engagement

Organisation	Comment	Response
Transport for London, Section 48 consultation, October 2012	Given the scale of this proposed scheme the Mayor remains concerned about the potential impacts of the scheme during construction on the Transport for London Road Network (TLRN) and all its users. To ensure that safe and efficient transport operations and infrastructure can be maintained during construction it is essential that these impacts are identified and minimised through appropriate mitigation measures.	Impacts on the highway network and its users are fully assessed in Section 12.5. Embedded measures are detailed in Section 12.2 with further detail provided in the Transport Assessment.
The City of London Corporation, Section 48 consultation, October 2012 Consultation workshop, September 2011	City of London. The proposed new position would require access to be provided from a narrow section of the riverside walk. This could cause pedestrian congestion in this area particularly since it is close to the Blackfriars station entrance. The final design would need to demonstrate suitable access arrangements whilst maintaining the integrity of the flood defences in this location. Further detailed design work is required to	A Pedestrian Level of Service assessment has been carried out for the site to assess pedestrian capacity. Results are reported in this assessment.

Organisation	Comment	Response
	determine whether a suitable replacement facility would be provided	
City of London Corporation/ Transport for London, Section 48 consultation, October 2012 Consultation workshop, September 2011	Need to minimise requirement for any loss of lane capacity on Embankment in all phases. If lane closures required they should be short-term and temporary and duration should be minimised.	The assessment has considered the implications of lane closures and diversions through the strategic modelling work (see Section 12.5). Consideration has also been given to this issue within the development of the construction methodology and programme. As described above, alternatives to closure of the westbound off ramp of Blackfriars Bridge have been considered, however these would require closure of one lane of the Embankment, which would have a greater impact on local highway operation.
City of London Corporation, consultation workshop, September 2011	Closure of slip road not acceptable to City of London, consider and present alternatives and maximise use of river.	Alternative options have been discussed at workshops with the City of London Corporation and TfL. Strategic modelling outputs indicate that the impacts on the wider network would be similar for all options considered, but that the alternative would result in significant queues on Victoria Embankment. The proposal to close the ramp during Phase 3 would reduce the scale and duration of utilities diversion works required.
City of London Corporation, consultation workshop, September 2011	Westbound off-ramp can be used by standard HGV, but not abnormal loads	This has been assumed in the assessment and taken into account in the construction vehicle routing proposals.
City of London Corporation, consultation workshop,	Structural strength of river wall / footway is not sufficient for vehicle loading.	Temporary bridging/strengthening of the Pauls Walk / Victoria Embankment footway for

Organisation	Comment	Response
September 2011		construction vehicles would be provided. The footway would be permanently strengthened locally for the operational access points.
City of London Corporation, consultation workshop, September 2011	City of London would prefer Millennium Pier to be reinstated to its current position post-construction. New position could cause pedestrian congestion in this area particularly since it is close to the Blackfriars station entrance.	The reinstatement of the Pier to its current location has been considered as part of design options for the operational phase. However, the proposal is not to reinstate the Pier to its original location and an assessment on pedestrian effects is included in this document (see Section 12.5).
City of London Corporation / Transport for London, consultation workshop, September 2011	Current traffic movements (2011) are not typical due to Blackfriars works. Need to check historical data.	Data have been collected from TfL as part of baseline data collection which includes historical data. Additional traffic surveys were also undertaken in May 2012 following completion of the upgrades to the Blackfriars Bridge (A201) / New Bridge Street (A201) junction.
City of London Corporation / Transport for London, consultation workshop, September 2011	Pedestrian flows at foreshore / subway will also need to be pre-Blackfriars works.	Data have been obtained from TfL for pedestrian assessments made prior to the works by Network Rail.
City of London Corporation / Transport for London, consultation workshop, September 2011	Provision of lifts at Blackfriars Bridge in the permanent layout.	A permanent lift is included within the permanent layout design to provide step-free access to the Thames Path and Blackfriars Millennium Pier.
City of London Corporation / Transport for London, consultation workshop,	Existing diversion routes for buses (with the westbound ramp closed) are only currently used for short-term closures. Implications of longer term closures need to	No bus routes currently use the westbound ramp and therefore no bus diversions would be required.

Organisation	Comment	Response
September 2011	be considered, particularly for night buses.	
City of London Corporation/ Transport for London, consultation workshop, September 2011	Coach parking would need to be relocated to enable construction access.	There is limited opportunity to relocate coach parking close to the site. The assessment considers the provision of alternative coach parking in the wider area.
City of London Corporation/ Transport for London, consultation workshop, September 2011	Farringdon Street and Victoria Embankment are approved construction vehicle routes. Farringdon Road is the approved route for abnormal loads.	The proposed construction routes reflect this.
City of London Corporation/ Transport for London, consultation workshop, September 2011	Need to assess impact on pedestrians of proposed relocation of pier and propose mitigation measures to ensure safe and good access/interchange.	Pedestrian routes to the relocated Pier have been considered in the design and assessment.
City of London Corporation / Transport for London, consultation workshop, September 2011	Permanent site access/crossover is over engineered considering the low level of operational access requirements.	This has been considered within the design of the operational phase to minimise the level of intervention whilst catering for maintenance vehicle access
City of London Corporation / Transport for London, consultation workshop, September 2011	It may be appropriate to consider vehicle diversion routes to the south of the river via Stamford Street. The use of Westminster Bridge as a diversion route may not be suitable	Diversion routes would be either north and west via Fleet Street and Arundel Street, or south and east via Southwark Street (A3200) and Southwark Bridge (A300). Westminster Bridge would not be used as a signed diversion route.
City of London Corporation / Transport for London, consultation workshop, September 2011	The use of Southwark Bridge may be limited due to a right turn ban at Southwark Street junction.	This is not expected to affect construction or diversion routes.

Organisation	Comment	Response
City of London Corporation / Transport for London, consultation workshop, September 2011	Strategic modelling will be necessary to determine the feasibility of all the options	Strategic modelling has been undertaken as part of the assessment (see Section 12.5).
City of London Corporation / Transport for London, consultation workshop, September 2011	Thames Path diversion – need clear plan for diversion during each phase, analysis of impact and proposed mitigation.	This is set out in the construction phase plans (see separate volume of figures – Section 1).
City of London Corporation/ Transport for London, consultation workshop, September 2011	Need to consider change / increase in pedestrian movements resulting from additional Thameslink services in future	This has been considered as part of the assessment (see Section 12.5).
City of London Corporation / Transport for London, consultation workshop, September 2011	At Blackfriars Embankment, the Mayor finds the prospect of the closure of the westbound slip road unacceptable.	Discussions have taken place with TfL on the options available for construction at this site. Strategic and local modelling has been undertaken to support the assessment and identify the likely impacts of the closure. Alternatives have been reviewed, however, it is considered that the closure of the slip road would have the least impact.
City of London Corporation/ Transport for London, consultation workshop, September 2011	Appropriate strategic and local traffic modelling should be undertaken. (S48	Strategic and local modelling has been undertaken for the Blackfriars Bridge Foreshore site as part of the assessment (see Section 12.5).
City of London Corporation/ Transport for London, consultation	Every effort should be made to look at ways to minimise the need for any works that require the loss of any lane capacity. If works must take	During Phases 1 and 2 of construction works at the Blackfriars Bridge Foreshore site the carriageway width of the westbound exit ramp road

Organisation	Comment	Response
workshop, September 2011	place then they should be for as short a period as possible and appropriate mitigation measures put in place.	would be reduced and in Phase 3 the closure of the westbound exit ramp road would be required. To limit the effects on transport networks, temporary lane closures would only be used when required and the road would be made available to general traffic at other time. A range of measures have been embedded directly in the design of the project including the CoCP.

Baseline

12.3.3 The baseline methodology follows the methodology described in Volume 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. There are no site-specific variations for undertaking the construction assessment of this site.

12.3.5 The effect of all other Thames Tideway Tunnel project sites on the area surrounding Blackfriars Bridge Foreshore 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 18 Appendix N), all of the other developments identified within 1km of the Blackfriars Bridge Foreshore site would be complete and operational by Site Year 2 of construction and therefore form part of the base case. This means that there are no cumulative effects to assess, although it is noted that the TfL Highway Assignment Models (HAM) have been developed using GLA (2011) employment and population forecasts, which are based on the employment and housing projections set out in the *London Plan 2011*[4]. As a result the assessment inherently takes into account a level of future growth and development across London.

Construction assessment area

12.3.7 The assessment area for Blackfriars Bridge Foreshore includes the site access directly from the westbound on-slip ramp, which is part of the Victoria Embankment (A3211) TLRN. The following roads and junctions in close proximity to the site have also been assessed:

a. Blackfriars Bridge Road (A201) and Victoria Embankment (A3211) slip roads

b. New Bridge Street (A201), Queen Victoria Street and Blackfriars Bridge Road (A201) junction

c. Upper Thames Street (A3211) and Puddle Dock junction

d. Queen Victoria Street and Puddle Dock junction

e. Victoria Embankment (A3211) and Temple Avenue junction.

12.3.8 These roads and junctions have been assessed for highway, cycle and pedestrian impacts. The Thames Path was included within the assessment due to its proximity to the development site. Effects on local bus services within 640m of the site and rail services within 960m of the site have also been assessed[i].

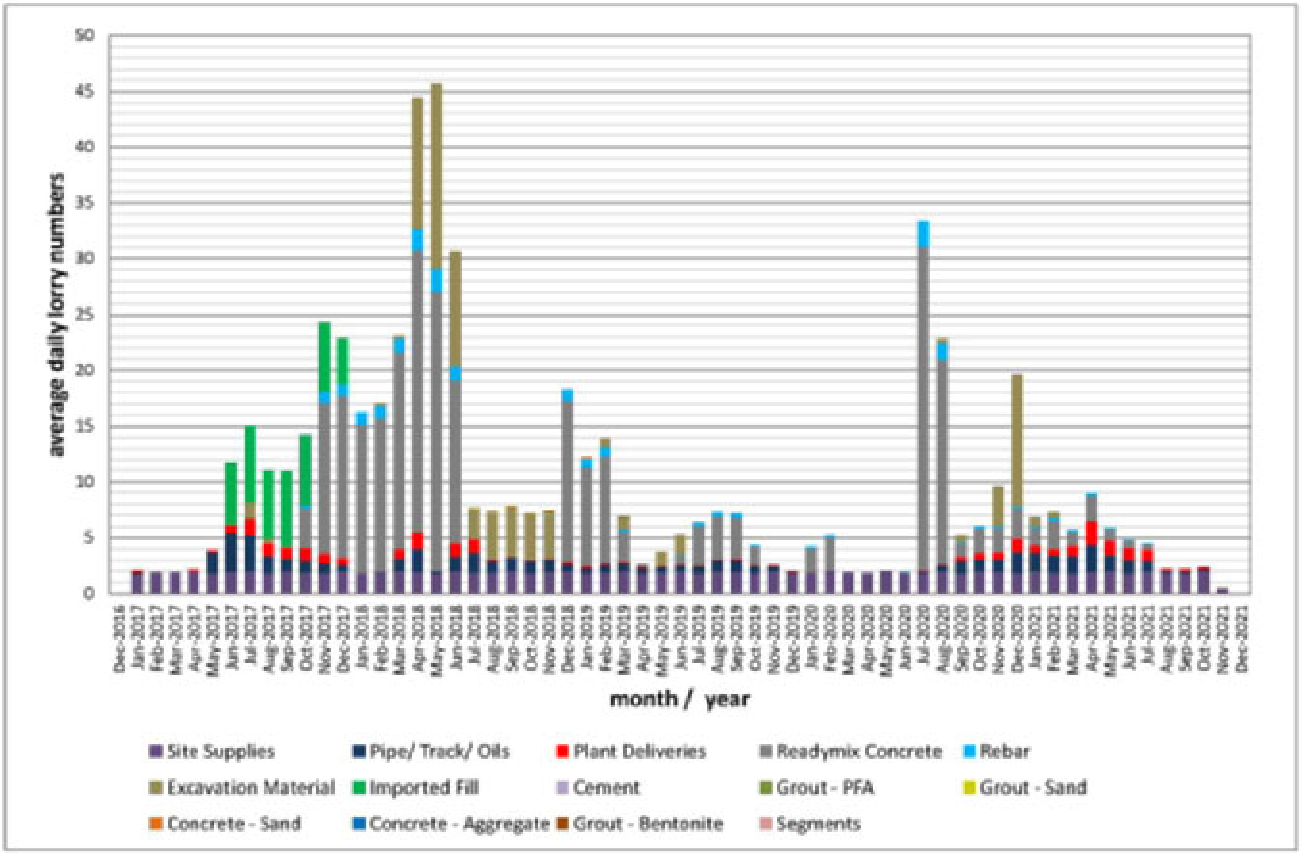
Construction assessment year

12.3.9 Site-specific peak construction assessment years have been identified. The histograms in Vol 18 Plate 12.3.1 and Vol 18 Plate 12.3.2 show that the peak site-specific activity at the Blackfriars Bridge Foreshore site would occur in Site Year 2 of construction for construction lorry movements and Site Year 4 of construction for construction barge movements.

12.3.10 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.

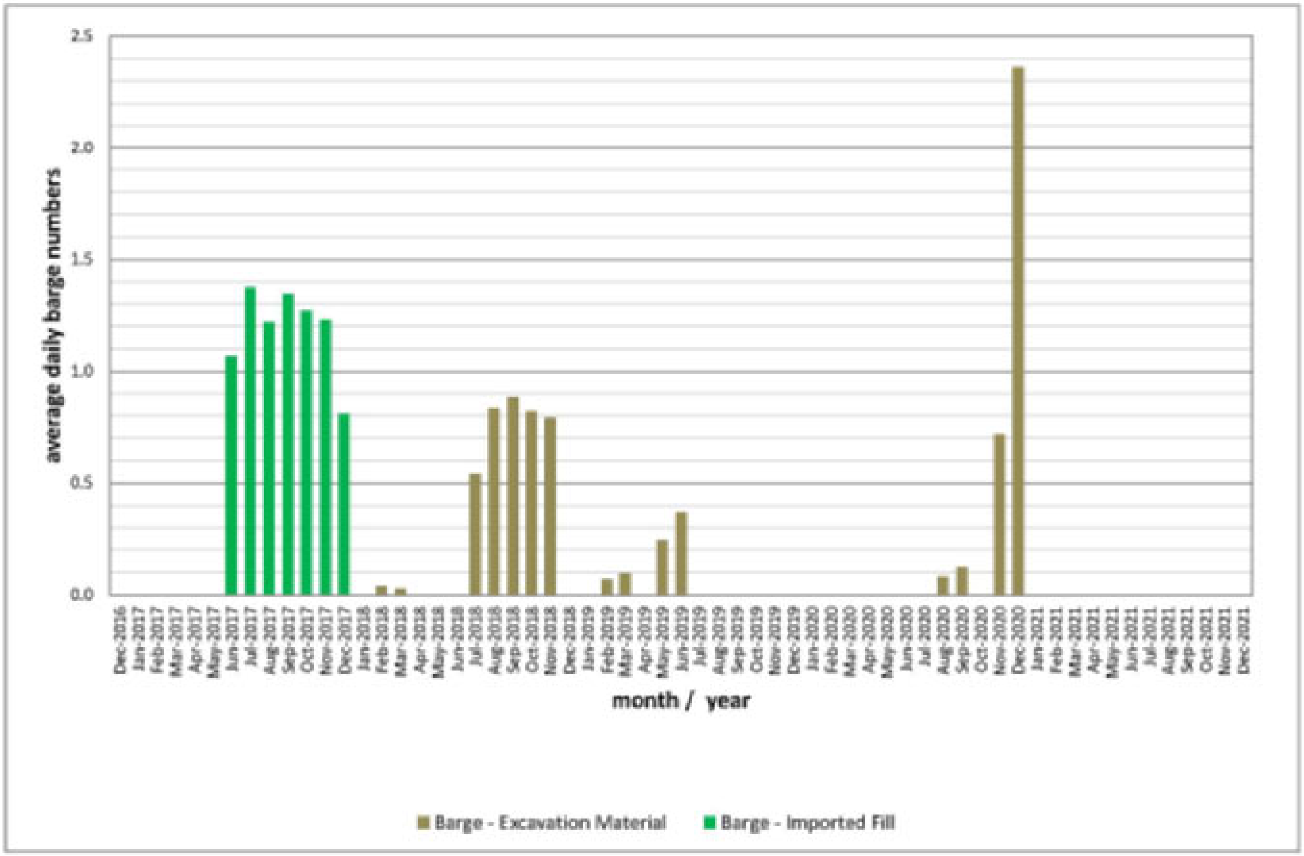
[i] Distances derived from the Public Transport Accessibility Level (PTAL) methodology described in Volume 2.

Vol 18 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 18 Plate 12.3.2 Transport – estimated construction barge profile



Note: Plate shows approximateh volumes and number of barge trips based upon assumed timings for the works. It is not a programme and remains subject to change.

Operation

12.3.11 The assessment methodology for the operational phase follows that described in Volume 2. There are no site-specific variations for undertaking the operational assessment of this site.

12.3.12 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 as a result of maintenance trips to the site, as these 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 in relation to maintenance activity in the operational phase are the effects on parking and highway layout and operation and users of the Blackfriars Millennium Pier.

12.3.13 These elements are considered qualitatively (as described in Volume 2) because the minimal effect on the highway network means that a quantitative assessment is not required. The scope of this analysis has been discussed with the City of London Corporation and TfL.

12.3.14 Given the level of the transport activity associated with the Thames Tideway Tunnel project during the operational phase, only the localised transport effects around the Blackfriars Bridge Foreshore site are assessed. Other Thames Tideway Tunnel project sites would not alter the local effects around the site and therefore have not been considered in the assessment.

12.3.15 With regard to other developments in the vicinity of the site (as detailed in the site development schedule, Vol 18 Appendix N), all the developments would be complete and operational by Year 1 of operation. As a result, these developments have been included within the operational base case which takes into consideration the effects on highway layout and operation, pedestrian routes and access to the river. There are no operational cumulative effects requiring assessment.

Operational assessment area

12.3.16 The assessment area for the operational assessment remains the same as for the construction assessment as set out in paras. 12.3.7 and 12.3.8.

Operational assessment year

12.3.17 As outlined in Volume 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.

12.3.18 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

12.3.19 The general assumptions and limitations associated with this assessment are presented in Volume 2.

Assumptions

12.3.20 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) in any event to ensure the effective operation of the highway network and respond to changes in traffic conditions.

12.3.21 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 Blackfriars Bridge Foreshore site, it is assumed that there would be one hazardous load per fortnight generated by the site.

12.3.22 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.12.5.3.

Limitations

12.3.23 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 The main site is located on the foreshore and footway adjacent to Blackfriars Bridge (A201). The Blackfriars Pier site is located to the east of Blackfriars Bridge opposite Puddle Dock. Both are in the City of London as shown in Vol 18 Figure 12.4.1 (see separate volume of figures).

Pedestrian routes

12.4.3 The existing pedestrian network and facilities in the vicinity of the site are shown in Vol 18 Figure 12.4.2 (see separate volume of figures).

12.4.4 The Thames Path runs along the southern footway of Victoria Embankment (A3211), adjacent to the river. The Thames Path continues to the east along Paul's Walk (a designated City Walkway), under Blackfriars Bridge, and to the west along Victoria Embankment (A3211). Paul's Walk provides a continuous pedestrian route of 3-4m in width from Blackfriars Bridge to the Millennium Bridge further east.

12.4.5 Pedestrians have access to New Bridge Street (A201) and Queen Victoria Street to the east of the site from Paul's Walk. At the lower level, there is a pedestrian underpass with eight exits leading directly from Paul's Walk in the south and connecting with New Bridge Street (A201), Queen Victoria Street, and Blackfriars Station in the north. The underpass has access to and from Blackfriars Bridge (A201) by stairs.

12.4.6 Blackfriars Bridge (A201) crosses the River Thames into the London Borough (LB) of Southwark and has footways on both sides of the road providing a north-south link for pedestrians between Victoria Embankment (A3211) and New Bridge Street (A201) to the north of the river and Blackfriars Road (A201), Southwark Street and Stamford Street (both A3200) to the south of the river.

12.4.7 The western side of the bridge is part of the Thames Path network linking the Thames Path on Victoria Embankment (A3211) and Paul's Walk to the north to the Thames Path along Marigold Alley to the south of the river.

12.4.8 The width of the footways on Blackfriars Bridge (A201) are approximately 7m. A signalised pedestrian crossing is located to the south of Blackfriars Bridge north of the junction of Blackfriars Bridge (A201) / Blackfriars Road (A201) / Upper Ground to aid east-west pedestrian movements. No further marked crossings are provided for pedestrians along the length of the bridge.

12.4.9 Victoria Embankment (A3211) provides a continuous east-west link for pedestrians along the north bank of the River Thames. Victoria Embankment (A3211) starts at Westminster Bridge, and then follows the course of the north bank, past Hungerford Bridge and Waterloo Bridge, before ending at Blackfriars Bridge.

12.4.10 The footways along either side of Victoria Embankment (A3211) are between 3m and 6m wide and have viewing / rest points located along the southern footway with an approximate distance of every 10-20m.

12.4.11 Signalised pedestrian crossing facilities are provided on the east side of the junction of Victoria Embankment (A3211) and Temple Avenue to aid north-south pedestrian movements.

12.4.12 Additional pedestrian crossings are located to the east of the site at the upper level at the junction of Victoria Embankment (A3211) with New Bridge Street (A201) / Blackfriars Bridge (A201) / Queen Victoria Street.

12.4.13 Pedestrian footways are provided on the eastbound and westbound ramps between Victoria Embankment (A3211) and the junction of Blackfriars Bridge (A201) / New Bridge Street (A201) / Victoria Embankment (A3211). There are no pedestrian footways through the underpass.

12.4.14 New Bridge Street (A201) and Temple Avenue provide north-south links between Victoria Embankment (A3211) and Fleet Street and Ludgate Hill to the north.

12.4.15 New Bridge Street (A201) has footways of between 3m and 4.5m on both sides of the road, providing a continuous north-south link of good quality between Victoria Embankment (A3211) and Ludgate Hill, Fleet Street and Farringdon Street to the north.

12.4.16 At the signalised junctions of New Bridge Street (A201) / Bridewell Place, and New Bridge Street (A201) / Farringdon Street / Ludgate Hill / Fleet Street, pedestrian crossing facilities with dropped kerbs are provided at all crossing points.

12.4.17 Queen Victoria Street to the northeast of the site provides a link between Blackfriars station and the site. The junction of Queen Victoria Street and New Bridge Street (A201) is the main pedestrian access to Blackfriars station for all pedestrians on the north side of the River Thames. Queen Victoria Street generally has footways of between 2.5m and 7m wide with pedestrian crossings provided at the junction of Queen Victoria Street and Puddle Dock.

12.4.18 Puddle Dock has footway on the eastern side only up to the junction with Upper Thames Street (A3211). The junction of Puddle Dock and Upper Thames Street (A3211) is signalised but provides no pedestrian facilities.

Cycle routes

12.4.19 The existing cycle network and facilities in the vicinity of the site are shown in Vol 18 Figure 12.4.2 (see separate volume of figures).

12.4.20 The nearest main cycle route within the area is National Cycle Network (NCN) Route 4 (on road) which routes through central London along Chelsea Embankment (A3212), Lambeth Bridge, Lambeth Palace Road, Belvedere Road, Upper Ground, Southwark Street (A3200), and Southwark Bridge Road (A300) on the south side of the River Thames. At Blackfriars the route is on the opposite bank of the river to the site.

12.4.21 An on-road cycle lane is provided along Victoria Embankment (A3211) between Temple Underground station and the junction with New Bridge Street (A201) / Blackfriars Bridge (A201) in both directions; however, the cycle lane is not present on the ramps leading to and from the junction on Blackfriars Bridge (A201). Queen Victoria Street is recommended by TfL as a quieter route for cyclists.

12.4.22 There are on-road cycle lanes along both sides of Blackfriars Bridge (A201) which connect to the NCN Route 4 on Blackfriars Road (A201). The route continues west along Upper Ground and east along Southwark Street (A3200) and links to Cycle Superhighway Route 7 (CS7) on Southwark Bridge Road.

12.4.23 On-road cycle lanes are provided along New Bridge Street (A201) in both directions, and advanced cycle stoplines are provided at all approaches to the junction of New Bridge Street (A201) / Fleet Street / Ludgate Hill / Farringdon Street (A201), and the junction of New Bridge Street (A201) / Bridewell Place / Apothecary Street.

12.4.24 Advanced cycle stoplines are provided for cyclists along Victoria Embankment (A3211) to the west of the junction with Temple Place and at the junction with Temple Avenue. Advanced cycle stoplines are also provided at the junction of Victoria Embankment (A3211) / New Bridge Street (A201) / Queen Victoria Street / Blackfriars Bridge (A201).

12.4.25 The section of the Thames Path which runs along the southern footway of Victoria Embankment cannot be used by cyclists. Instead, cyclists are able to use the on-street cycle lanes.

12.4.26 There is a cycle hire docking station opposite the site, on the northern footway of Victoria Embankment (A3211) to the east of the junction with Temple Avenue. This cycle docking station accommodates 20 bicycles.

12.4.27 A further 17 docking spaces are provided on Bouverie Street, 300m walking distance from the site to the north. There are 18 more docking spaces on Milford Lane and 24 on Godliman Street approximately 400m walking distance to the west and 700m walking distance to the east of the site respectively. On Queen Victoria Street 760m walking distance to the east of the site, 32 docking spaces are provided.

12.4.28 There are approximately 100 cycle parking spaces available in the Baynard House car park located on Queen Victoria Street approximately 500m walking distance northeast of the site.

12.4.29 Four cycle stands capable of accommodating up to eight bicycles are provided on the northern footway of Victoria Embankment (A3211) at the junction with Carmelite Street, approximately 30m walking distance north of the site. A further four cycle stands are available on the footway of Victoria Embankment (A3211) outside Temple Underground station, approximately 480m walking distance west of the site.

12.4.30 Three cycle stands are provided along New Bridge Street (A201), two approximately 500m walking distance north of the site at the junction with Bridewell Place and one approximately 500m walking distance to the north at the junction with Fleet Street / Ludgate Hill / Farringdon Street.

12.4.31 Approximately 200m walking distance to the east of the site, outside Blackfriars Station, on Queen Victoria Street, a total of 10 cycle stands are provided, capable of accommodating up to 20 bicycles.

Public Transport Accessibility Level

12.4.32 The Public Transport Accessibility Level (PTAL) of the site has been calculated using TfL's approved PTAL methodology (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).

12.4.33 Using this methodology the site has a PTAL rating of 6b, rated as 'excellent' (with 1 being the lowest accessibility and 6b being the highest accessibility).

12.4.34 Vol 18 Figure 12.4.3 (see separate volume of figures) shows the public transport network around the Blackfriars Bridge Foreshore site.

Bus services

12.4.35 As shown in Vol 18 Figure 12.4.3 (see separate volume of figures), a total of 14 daytime bus routes and ten night bus routes operate within a 640m walking distance of the site serving the local destinations. Two bus routes (23 and 341) are 24-hour routes.

12.4.36 These bus routes operate from the following bus stops:

a. Blackfriars Station bus stop on New Bridge Street (A201) - northbound and southbound, 300m walking distance to the northeast

b. Blackfriars Bridge bus stop on Blackfriars Road (A201) - westbound only, 420m walking distance to the southeast City Thameslink Station bus stop on Ludgate Hill - westbound only, 450m walking distance to the northeast

c. Ludgate Circus bus stop on Fleet Street - eastbound only, 500m walking distance to the north

d. Fleet Street bus stop on Farringdon Street - southbound only, 520m walking distance to the northeast

e. Blackfriars Road bus stop on Southwark Street (A3200) - eastbound and westbound, 640m walking distance to the southeast.

12.4.37 These routes also serve other stops further from the site as shown on Vol 18 Figure 12.4.3 (see separate volume of figures).

12.4.38 On average there are 220 and 222 daytime bus services per hour in the AM and PM peak hours respectively within a 640m walking distance of the site.

12.4.39 There are approximately 41 night-time bus services per hour Monday – Friday between 00:00 – 06:00 and 48 bus services per hour on Saturdays between 00:00 – 06:00 within a 640m walking distance of the site.

London Underground

12.4.40 Temple, Blackfriars, Mansion House and Southwark Underground stations are located within a 960m walking distance of the site to the west, east, northeast and south respectively.

12.4.41 As shown on Vol 18 Figure 12.4.3 (see separate volume of figures), Temple Underground station, which is served by the Circle and District lines, is located approximately 800m walking distance to the west of the site. Circle Line trains serving this station travel clockwise to Edgware Road and anti-clockwise to Hammersmith. District Line trains travel west from Edgware Road to Ealing Broadway, Richmond, Wimbledon and Kensington (Olympia), and east to Upminster.

12.4.42 Blackfriars Underground station is approximately 300m walking distance to the east of the site. Mansion House is approximately 950m walking distance to the northeast of the site. Both stations are served by the same Circle and District Line services that call at Temple.

12.4.43 In the AM and PM peaks, the frequency of the Circle Line trains is approximately every ten minutes providing six services per hour in each direction and the frequency of the District Line trains is approximately every three minutes providing 21-22 services per hour in each direction.

12.4.44 Southwark station is approximately 940m walking distance to the south of the site.

12.4.45 Jubilee Line trains serving this station travel west to Stanmore and Wembley, and east to Greenwich and Stratford. In the AM and PM peaks, the frequency of Jubilee Line trains is approximately every 3-5 minutes providing 27-29 services per hour in each direction.

12.4.46 On average there are 55 underground services in total during the AM and PM peak hours within a 960m walking distance of the site.

National Rail

12.4.47 As shown on Vol 18 Figure 12.4.3 (see separate volume of figures), the closest National Rail stations are Blackfriars (300m walking distance to the northeast) and City Thameslink (500m walking distance to the north of the site).

12.4.48 Blackfriars Station provides access to First Capital Connect and Southeastern train services and provides northbound services to Bedford, Luton, St Albans, West Hampstead Thameslink, and Kentish Town, and southbound services to Brighton, Sutton, Three Bridges, Sevenoaks, Rochester and Ashford International.

12.4.49 In the AM peak hour there are approximately 28 services (14 southbound and 14 northbound). In the PM peak hour there are approximately 26 services (13 southbound and 13 northbound).

12.4.50 City Thameslink Station provides access to First Capital Connect train services and provides services as detailed in para. 12.4.49 for Blackfriars Station.

River passenger services

12.4.51 There are two piers within walking distance of the site which provide river passenger services. Blackfriars Millennium Pier is within the site, immediately west of Blackfriars Bridge and Temple Pier lies 500m walking distance west of the site on the north bank. These river services are shown on Vol 18 Figure 12.4.3 (see separate volume of figures).

12.4.52 Temple Pier is used by leisure cruises with no set timed departures, with Capital Pleasure Boats operating from this pier.

12.4.53 Blackfriars Millennium Pier is served by river bus and leisure cruise services, operated by Thames Clipper and Thames Executive Charters respectively. Thames Clipper services run between St George Wharf in the west and Woolwich Arsenal Pier in the east. The river services operated by Thames Executive charters run between Putney Pier in the west and Blackfriars Millennium Pier.

12.4.54 Eastbound Thames Clippers services from Blackfriars Millennium Pier start at 07:07 running until 23:19 and westbound services start at 06:49 running until 22:58. At weekends, no Thames Clippers service runs from this pier.

12.4.55 During the AM weekday peak, the frequency of the westbound service is approximately every 10-20 minutes and during the PM weekday peak, the frequency reduces to every 20-30 minutes. The eastbound service runs approximately every 10-20 minutes during the AM and PM weekday peaks.

12.4.56 In the weekday AM peak hour, both eastbound and westbound Thames Executive Charters services from this pier begin at 07:00 running until 09:35 with three eastbound services and only one westbound service. During the PM peak hour, one eastbound and one westbound service operate from the pier. On weekends, there is no Thames Executive Charters service from this pier.

12.4.57 Both Blackfriars Millennium Pier and Temple Pier are currently accessed from the southern footway of Victoria Embankment (A3211).

River navigation and access

12.4.58 As described above, there are two piers within 960m walking distance of the site,

12.4.59 An analysis has been made of the typical volume of river vessel traffic passing the Blackfriars Bridge Foreshore site, based on published river passenger service timetables and estimates of freight traffic based on discussions with operators. It is estimated that the peak hour for river vessel traffic passing the site is between 15:00 and 16:00, Monday to Friday. During this hour approximately 36 vessels are estimated to pass the site. This figure is not constant as freight vessel transit patterns, which are included in the traffic, 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

12.4.60 Vol 18 Figure 12.4.4 (see separate volume of figures) shows the locations of the existing car parking and car club spaces within the vicinity of the site.

Existing on-street car parking

12.4.61 There are four car parking bays with a permitted wait time of 20 minutes along the eastbound slip road from Victoria Embankment (A3211) to New Bridge Street (A201).

12.4.62 A total of approximately 53 pay and display parking bays are available and parking for up to 214 motorcycles is provided on the roads adjacent to the site.

12.4.63 On Temple Avenue, John Carpenter Street and Tallis Street, there are six blue badge parking bays.

12.4.64 There are no resident parking bays available on roads in the vicinity of the site.

Existing off-street/private car parking

12.4.65 There are four private car parks close to the site. These are:

a. Bouverie Street - approximately 330m walking distance to the north of the main site

b. Baynard House car park - approximately 450m walking distance to the east of the main site on Queen Victoria Street. This 24-hour car park has 287 spaces

c. Little New Street (International Press Centre) car park - . approximately 640m walking distance to the north of the main site with 70 spaces

d. Limeburner Street (Hillgate House) car park - approximately 720m walking distance to the northwest of the main site.

Coach parking

12.4.66 Coach parking is provided on the westbound slip road between Blackfriars Bridge (A201) and Victoria Embankment (A3211). The parking bays can accommodate two coaches.

12.4.67 There are two additional coach parking bays on Temple Place approximately 500m to the west of the site. Approximately 500m to the northeast of the site on Queen Victoria Street, eight on-street metered coach parking bays are provided.

Car clubs

12.4.68 The closest car club parking space to the site is operated by ZipCar and is approximately 300m walking distance to the west of the site on Temple Place where one car space is provided.

Servicing and deliveries

12.4.69 A loading bay is located approximately 130m walking distance to the west of the Blackfriars Bridge (A201) / New Bridge Street (A201) junction on the Victoria Embankment (A3211) westbound on-slip.

12.4.70 A further loading bay is located on Victoria Embankment (A3211) approximately 180m to the west of the Victoria Embankment (A3211) / Temple Avenue junction.

Taxis

12.4.71 The nearest taxi ranks to the site are 300m walking distance to the north of the site on John Carpenter Street with two taxi spaces and on Tudor Street approximately 400m to the northwest with three taxi spaces.

12.4.72 Three taxi ranks are located to the east of the site on both sides of Queen Victoria Street, close to Blackfriars station. Each taxi rank accommodates three taxis.

Highway network and operation

12.4.73 As shown in Vol 18 Figure 12.4.1 (see separate volume of figures), the main site is located approximately 150m to the west of the signalised junction of Victoria Embankment (A3211) / Blackfriars Bridge (A201) / New Bridge Street (A201) / Queen Victoria Street and the Blackfriars Pier site is located to the east of Blackfriars Bridge opposite Puddle Dock.

12.4.74 Victoria Embankment (A3211) is a two-way dual carriageway with a 30mph speed limit and forms part of the TLRN and as such is suitable for HGVs and long vehicles. The road links to New Bridge Street (A201), Blackfriars Bridge (A201) and Upper Thames Street (A3211) in the east, and Bridge Street (A302) and Westminster Bridge Road (A302) in the west.

12.4.75 To the east of the junction with Temple Avenue, Victoria Embankment (A3211) divides. The Blackfriars underpass continues under Blackfriars Bridge (A201), whilst slip roads to and from Victoria Embankment (A3211) connect with the junction with New Bridge Street (A201), Queen Victoria Street, and Blackfriars Bridge (A201).

12.4.76 New Bridge Street (A201) is also part of the TLRN and has one northbound and two southbound lanes in the vicinity of the junction with Victoria Embankment (A3211) / Blackfriars Bridge (A201) / Queen Victoria Street.

12.4.77 Queen Victoria Street is a single carriageway with two lanes on the approach to and exit from the junction with New Bridge Street (A201) / Blackfriars Bridge (A201) / Victoria Embankment (A3211). Queen Victoria Street is not part of the TLRN or the Strategic Road Network (SRN).

12.4.78 At the lower level, the Blackfriars underpass provides an east-west link between Victoria Embankment (A3211) to the west and Upper Thames Street (A3211) to the east.

12.4.79 The junction of Puddle Dock and Upper Thames Street (A3211) to the west of the site is signalised and provides a right turn facility for vehicles on Upper Thames Street (A3211) to access Puddle Dock and Queen Victoria Street. Access from Puddle Dock to Upper Thames Street (A3211) is via Castle Baynard Street, which acts as a slip road on to the eastbound carriageway.

12.4.80 Blackfriars Bridge (A201) forms part of the TLRN with one lane, a bus lane, and a cycle lane in both directions.

12.4.81 There are a number of signalised junctions along Victoria Embankment (A3211) to the west of Temple Avenue, including those at Temple Place, Savoy Street, Northumberland Avenue (A308), and Horse Guards Avenue. Victoria Embankment (A3211) extends as far west as the junction with Westminster Bridge Road (A302) and Bridge Street (A302) which is 1.8km from the site.

Data from third party sources

Description of data

12.4.82 Data in relation to traffic flows and accidents have been sourced from TfL:

a. five year accident data on roads within the vicinity of the site

b. Automatic Traffic Counts (ATCs)

c. TRANSYT 12 model of Victoria Embankment (A3211) and associated junction movement data

d. TRANSYT 12 model of New Bridge Street (A201) and associated junction movement data

e. LinSig model of Puddle Dock / Upper Thames Street (A3211) junction.

Accident analysis

12.4.83 A total of one fatal accident, 17 serious and 80 slight accidents have occurred in the assessment area over the five years of accident data analysed.

12.4.84 The one fatal accident that occurred within the assessment area happened at the junction of Victoria Embankment (A3211) and Temple Avenue. It involved the death of a motorcyclist and was attributed to the motorcyclist passing too close to a cyclist.

12.4.85 Of the total accidents, 28 accidents in the assessment area involved LGVs, MGVs, and HGVs. Of these accidents, 23 were slight accidents and the remaining five accidents were serious accidents.

12.4.86 In total, seven pedestrians were involved in the accidents, and three of these were recorded as serious and four as slight accidents.

12.4.87 Of the total accidents, 42 accidents involved cyclists of which nine were classified as serious and the remaining 33 accidents were slight.

12.4.88 Of the five years of accident data analysed none of the accidents happened as a result of the road geometry.

Traffic flow data analysis

12.4.89 ATC data for the Victoria Embankment (A3211) were obtained from TfL and analysed to identify the traffic flows in 2011. The weekday vehicle flows for a 12-hour period (07:00-19:00) show that the PM peak for Victoria Embankment (A3211) is the busiest hour with a two-way flow of approximately 3,225 vehicles per hour.

12.4.90 In addition, junction movement data from both TRANSYT and LinSig models for the junctions outlined in paras. 12.4.91 to 12.4.93 were also obtained from TfL and assessed alongside the traffic surveys undertaken in 2011 for the project.

12.4.91 Junction movement data from the TRANSYT model indicate that there is a total flow of 3,237 and 3,258 vehicles in the AM and PM peak hours respectively using Victoria Embankment (A3211) / Temple Avenue junction. The flow is balanced in both eastbound and westbound directions in the AM and PM peak hours.

12.4.92 Junction movement data from the TRANSYT model indicate that a total traffic flow of 3,234 and 3,243 uses the junction of Blackfriars Bridge (A201) / New Bridge Street (A201) / Queen Victoria Street / Victoria Embankment (A3211) in the AM and PM peak hours respectively. The flow is relatively balanced in both directions in both peak hours. However there is a higher volume of northbound flow in the AM peak hour and a corresponding higher flow southbound in the PM peak hour by approximately 200 vehicles.

12.4.93 Junction movement data from the LinSig model indicate that a total traffic flow of 688 and 537 uses Puddle Dock to access Queen Victoria Street in the AM and PM peak hours respectively. The model data for Upper Thames Street (A3211) showed two-way traffic flow to be approximately 2,111 and 2,021 in the AM and PM peak hours respectively. It is noted that this is considerably lower than the flow shown on Victoria Embankment (A3211) in para. 12.4.92.

Survey data

Description of surveys

12.4.94 Baseline survey data were collected in May, July, and August 2011 and May 2012 (after Blackfriars Station reopened) to establish the existing transport movements and usage of parking in the area. Vol 18 Figure

12.4.5 (see separate volume of figures) shows the survey locations in the vicinity of the site.

12.4.95 As part of surveys in May, July and August 2011 and May 2012, manual and automated traffic surveys were undertaken to establish specific traffic, pedestrian and cycle movements including turning volumes, queue lengths and traffic signal timings. Parking surveys were undertaken in May 2011 to establish the usage of pay and display parking in addition to coach parking, loading bays and motorcycle bays.

12.4.96 Further surveys were conducted in August 2011 to establish the summer usage of the Thames Path along Victoria Embankment (A3211) to the west of Blackfriars Bridge (A201) and Paul's Walk.

12.4.97 As part of surveys in May 2012, journey time surveys were undertaken along Victoria Embankment (A3211) from the City of London to Westminster Bridge (A302).

Results of the surveys

12.4.98 The surveys inform the baseline situation in the area surrounding the site.

Pedestrians and cyclists

12.4.99 The results of the pedestrian surveys indicate that the westbound pedestrian movement is dominant during the AM peak hour along Victoria Embankment (A3211) past the site with approximately 220 pedestrians walking westbound and 130 walking eastbound. During the PM peak hour the flow is considerably heavier with approximately 370 westbound pedestrians and 280 eastbound pedestrians in the same location.

12.4.100 To establish the Pedestrian Level of Service[ii] (LoS – see Volume 2) along the footways surrounding the site, a LoS assessment was undertaken and the results indicate there is adequate capacity for pedestrians within the existing network. The main corridor for pedestrians, Paul's Walk, operates at LoS B during the AM and PM peak hours for pedestrians which represents conditions in which pedestrians feel there is sufficient space to walk and select routes without hindrance.

12.4.101 The flow of bicycles along the Blackfriars underpass (A3211) has been extracted from the survey data. This shows that there are 765 cyclists heading eastbound during the AM peak hour and 738 cyclists travelling westbound during the PM peak hour.

12.4.102 It should be noted that cyclists were recorded in the survey on Paul's Walk (Thames Path) even though cycling is not permitted here.

Traffic flows

12.4.103 The traffic flows for the junctions outlined in para. 12.3.7 are indicated in Vol 18 Figure 12.4.6 and Vol 18 Figure 12.4.7 (see separate volume of figures). These diagrams also take into consideration the TfL data collected.

[ii] Pedestrian Level of Service is a way of relating pedestrian densities to the degree of convenience that people experience on footways.

12.4.104 Traffic surveys indicate a total flow of 3,624 and 3,340 during the AM and PM peak hours at the junction of Victoria Embankment / Blackfriars Underpass (A3211) / Temple Avenue. During the AM and PM peak hours there is a total flow of 3,224 and 3,219 vehicles respectively at the junction of Farringdon Street (A201) / New Bridge Street (A201) / Fleet Street (A4) / Ludgate Hill. At the junction of Upper Thames Street (A3211) and Puddle Dock there is a total traffic flow of 1,669 vehicles in the AM peak hour and 1,610 vehicles during the PM peak hour.

12.4.105 ATC data have been analysed to identify the existing traffic flows along the Victoria Embankment (A3211) slip roads and the Blackfriars underpass as these flows are likely to experience the greatest impacts from the project. The AM peak hour is the busiest hour on the eastbound slip road with a maximum of approximately 150 vehicles every 15 minutes. On the westbound slip road the PM peak is the busiest hour with a maximum of approximately 110 vehicles every 15 minutes.

Parking

12.4.106 The results of the surveys indicate that usage of the coach, loading and motorcycle bays along the Victoria Embankment (A3211) is heavy, although there is still spare capacity available on both weekdays and at weekends. Along the length of Victoria Embankment (A3211) there are 48 coach parking spaces, with an observed highest daily occupancy of 29 vehicles (60% of capacity), 24 loading bays with an observed highest daily occupancy of three vehicles (13% of capacity), and 131 motorcycle spaces with an observed highest daily occupancy of 113 vehicles (86% of capacity).

12.4.107 Surveys were also undertaken to establish the availability of pay and display parking in the vicinity of the site to understand existing occupancy and capacity. Results indicate there is spare capacity along Victoria Embankment (A3211) and Temple Place as the spaces in these locations are not heavily used for the majority of the day. Along the length of Victoria Embankment (A3211) there are 19 pay and display spaces, with an observed highest daily occupancy of one vehicle (5% of capacity).

12.4.108 Along Temple Place there are 33 parking bays, made up of 20 pay by phone, ten pay and display and three residents parking bays with an observed highest daily occupancy of 16 vehicles (48% of capacity).

Local highway modelling

12.4.109 To establish the existing capacity on the local highway network, a scope was discussed with TfL and the City of London Corporation to model the junctions outlined in para. 12.3.7 using a LinSig traffic model.

12.4.110 The baseline model incorporates the separate TRANSYT and LinSig models set out in para. 12.4.82 to determine the traffic and transport conditions within the vicinity of the site. This follows the methodology outlined in Volume 2.

12.4.111 The weekday AM and PM baseline model queues for Blackfriars Bridge Road (A201), Victoria Embankment (A3211), New Bridge Street (A201), Queen Victoria Street, Upper Thames Street (A3211), Puddle Dock and

Temple Avenue were compared against both the observed traffic data and TfL base model outputs for the peak periods to validate the LinSig model and ensure reasonable representation of existing conditions.

12.4.112 The LinSig models for the junctions of Blackfriars Bridge (A201) / Victoria Embankment (A3211) westbound slip road, and Blackfriars Bridge Road (A201) / New Bridge Street (A201) / Queen Victoria Street are based on the revised junction layout and operation following completion of the Blackfriars Station improvement works.

12.4.113 Vol 18 Table 12.4.1 shows the modelling outputs for the baseline case for the junctions outlined in para. 12.3.7.

12.4.114 The modelling results indicate that:

a. the junction of Blackfriars Bridge Road (A201) with the Victoria Embankment (A3211) westbound slip road operates above theoretical capacity in the AM peak hour and within capacity in the PM peak hour

b. the junction of Victoria Embankment (A3211) and Temple Avenue operates above capacity in the AM peak hour and just within capacity in the PM peak hour

c. the junction of Blackfriars Bridge Road (A201), New Bridge Street (A201) and Queen Victoria Street operates above capacity in both peak hours

d. the junction of Queen Victoria Street and Puddle Dock operates within capacity in the AM and PM peak hours

e. the junction of Upper Thames Street (A3211), Puddle Dock and Blackfriars Passage operates within capacity in both the AM and PM peak hours.

12.4.115 The model shows that the greatest delay per vehicle in the AM and PM peak hours is at the junction of Blackfriars Bridge Road (A201), New Bridge Street (A201) and Queen Victoria Street. In the AM peak hour the maximum delay per vehicle is on New Bridge Street (A201) ahead movement, with an average of 68 seconds delay per vehicle and on Queen Victoria Street left movement with an average of 93 seconds of delay per vehicle. In the PM peak hour the maximum delay per vehicle is along the northbound Blackfriars Bridge Road (A201) right turn movement with an average of 114 seconds delay per vehicle on New Bridge Street (A201) with an average delay 90 seconds per vehicle and on the westbound carriageway of Queen Victoria Street for vehicles turning left into Blackfriars Bridge Road (A201) with an average of 96 seconds of delay per vehicles.

Vol 18 Table 12.4.1 Transport – baseline LinSig model outputs

Approach	Movement	Weekday							
		AM peak hour (08:00-09:00)				PM peak hour (17:00-18:00)			
		Flow (PCU)	DoS	MMQ (PCU)	Delay per PCU (seconds)	Flow (PCU)	DoS	MMQ (PCU)	Delay per PCU (seconds)
Junction of Blackfriars Bridge Road (A201) / Victoria Embankment (A3211) westbound slip road									
Blackfriars Bridge Road (A201) - northbound	Ahead / left	932	97.6%	33	63	560	81%	15	40
	Ahead	455	47.4%	8	19	314	46%	7	27
Blackfriars Bridge Road (A201) southbound, to Victoria Embankment (A3211)	Right	258	54%	6	48	273	40%	7	35
Victoria Embankment (A3211) - eastbound slip-road	Ahead (nearside lane)	277	82%	9	69	256	87%	9	71
	Ahead (offside lane)	128	34	3	47	122	42%	3	37
		PRC		**Total delay (PCU hours)**		**PRC**		**Total delay (PCU hours)**	
Overall junction performance		**-8%**		**29.7**		**4%**		**18**	
Junction of Victoria Embankment (A3211) / Temple Avenue									
Victoria Embankment (A3211) - eastbound	Ahead (nearside lane)	1075	100%	45	80	955	89%	24	30
	Ahead (offside lane)	829	78%	17	21	706	66%	12	17
Victoria Embankment	Ahead (nearside lane)	245	23%	3	15	315	29%	3	7

Approach	Movement	Weekday							
		AM peak hour (08:00-09:00)				PM peak hour (17:00-18:00)			
		Flow (PCU)	DoS	MMQ (PCU)	Delay per PCU (seconds)	Flow (PCU)	DoS	MMQ (PCU)	Delay per PCU (seconds)
(A3211) - westbound	Ahead (offside lane)	610	56%	10	14	681	63%	12	16
	Ahead (offside lane)	791	73	15	18	699	64	12	16
Temple Avenue	Right	74	15%	2	27	127	25%	3	29
		PRC		**Total delay (PCU hours)**		**PRC**		**Total delay (seconds)**	
Overall junction performance		**-11.9%**		**39**		**1%**		**22**	
Junction of Blackfriars Bridge Road (A201) / New Bridge Street (A201) / Queen Victoria Street									
Blackfriars Bridge Road (A201) - northbound	Ahead (nearside lane)	682	63%	6	6	754	73%	5	7
	Ahead (offside lane)	704	64%	18	14	256	25%	3	4
	Right	424	99%	16	75	204	95%	11	114
New Bridge Street (A201)	Ahead	445	74%	11	39	671	86%	18	40
	Ahead	567	94%	20	68	780	100%	33	90
Queen Victoria Street	Left	293	93%	12	93	364	95%	15	96
	Left / right	187	59%	5	31	210	55%	5	24
		PRC		**Total delay (PCU hours)**		**PRC**		**Total delay (seconds)**	
Overall junction performance		**-5%**		**39**		**-11%**		**47**	

Approach	Movement	Weekday							
		AM peak hour (08:00-09:00)				PM peak hour (17:00-18:00)			
		Flow (PCU)	DoS	MMQ (PCU)	Delay per PCU (seconds)	Flow (PCU)	DoS	MMQ (PCU)	Delay per PCU (seconds)
Junction of Queen Victoria Street / Puddle Dock									
Queen Victoria Street - eastbound	Ahead	182	23%	5	16	209	26%	5	18
	Ahead / right	242	31%	6	18	16	3%	1	20
Queen Victoria Street – westbound	Ahead	140	25%	3	29	152	29%	4	30
	Ahead / left	169	30%	4	29	186	35%	4	31
Puddle Dock	Right / left	411	70%	7	46	386	72%	12	35
	Right	247	76%	8	58	158	52%	5	56
		PRC		**Total delay (PCU hours)**		**PRC**		**Total delay (seconds)**	
Overall junction performance		**19%**		**14**		**29%**		**11**	
Junction of Upper Thames Street (A3211) / Puddle Dock / Blackfriars Passage									
Upper Thames Street (A3211) - eastbound	Ahead / left	706	59%	5	9	593	62%	7	14
	Ahead	829	67%	5	8	706	70%	8	14
Upper Thames Street (A3211) - westbound	Right	306	71%	8	44	231	36%	5	24
Blackfriars Passage	Ahead	220	37%	1	5	248	41%	1	5
		PRC		**Total delay**		**PRC**		**Total delay**	

Approach	Movement	Weekday							
		AM peak hour (08:00-09:00)				PM peak hour (17:00-18:00)			
		Flow (PCU)	DoS	MMQ (PCU)	Delay per PCU (seconds)	Flow (PCU)	DoS	MMQ (PCU)	Delay per PCU (seconds)
				(PCU hours)				(seconds)	
Overall junction performance		27%		9		29%		7	

Notes: 1. DoS represents Degree of Saturation; the ratio of flow to capacity. MMQ represents Mean Maximum Queue for the busiest-case 15 minute modelled period (in vehicle lengths). PRC represents overall Practical Reserve Capacity; measure of how much additional traffic could pass through a junction whilst maintaining a maximum DoS of 90% on all lanes. Delay represents the mean delay per PCU. PCU value for a car is one PCU. Vans and three-axle vehicles are 1.5 PCUs, vehicles with four or more axles are 2.3PCUs. Buses and coaches are two PCUs. Motorcycles and pedal cycles are 0.4 PCUs.

Transport receptors and sensitivity

12.4.116 The transport receptor sensitivity is defined as high, medium or low using the criteria detailed in Volume 2. Vol 18 Table 12.4.2 indicates the receptors and their sensitivities for the Blackfriars Bridge Foreshore site.

12.4.117 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.

12.4.118 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 18 Table 12.4.2 Transport – receptors and sensitivity

Receptors (relating to all identified transport effects)	Phase at which receptor is sensitive to identified impacts	Value/sensitivity and justification
Pedestrians (including sensitive pedestrians[iii]) using Paul's Walk and Thames Path	Construction Operation	High sensitivity to footway closures and diversions, resulting in increases to journey times
Cyclists travelling on roads in the immediate vicinity of the site	Construction	High sensitivity to closures and diversions, resulting in increases to journey times
Private vehicle users (including taxis) in the area using the local highways or on-street parking	Construction Operation	Medium sensitivity to journey time delays as a result of closures, diversions and increases to traffic flows and changes to parking

[iii] 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 impacts	Value/sensitivity and justification
		provision in the local area Low sensitivity of on-street parking due to distance from the site
Emergency vehicles travelling on roads in the immediate vicinity of the site	Construction Operation	High sensitivity to journey time delays due to time constraints on journey purposes
Marine emergency services	Construction	High sensitivity to changes in vessel movements / moorings
Coaches and service vehicles using parking facilities on the westbound Victoria Embankment (A3211) slip road adjacent to the site	Construction	High sensitivity to changes to parking capacity due to limited availability of parking
Bus users (passengers) travelling on routes in the surrounding area	Construction	Medium sensitivity to journey time delays as a result of diversions, closures and increases to traffic flows
River vessel operators	Construction	Medium sensitivity to increases in passage of construction barges and changes to moorings
Leisure users of the River Thames	Construction	High sensitivity to increases in passage of construction barges and changes to moorings / access to the river

Receptors (relating to all identified transport effects)	Phase at which receptor is sensitive to identified impacts	Value/sensitivity and justification
Pier operators and passengers using Blackfriars Millennium Pier	Construction Operation	Medium sensitivity to changes to river service, navigation patterns, pier location and access
Public transport users using rail or river services within the wider area	Construction	Low sensitivity due to low numbers of construction workers
Kings Bench Walk residents, 60m north of main site	Construction	High sensitivity to increases in HGV traffic and changes to pedestrian environment and highway layout changes including highway capacity modifications resulting in journey time delays
Users of Sion Hall and Audit House, both approximately 25m north of main site Users of specialist sports facility, within main site boundary Operators of President vessel, 20m west of main site Users of Inner Temple Garden, 25m north of main site Users of buildings 40-60 Victoria Embankment, 30m north of main site Staff and users of Mermaid Conference Centre, 30m north of Blackfriars Pier site Pupils, parents and staff of City of London School, 170m to the	Construction	Medium sensitivity to increases in HGV traffic and changes to pedestrian environment and highway layout changes including highway capacity modifications resulting in journey time delays

Receptors (relating to all identified transport effects)	Phase at which receptor is sensitive to identified impacts	Value/sensitivity and justification
northeast of Blackfriars Pier site		

Construction base case

12.4.119 As described in Section 12.3 above, the construction assessment year for transport effects in relation to this site is Site Year 2 of construction in relation to road traffic and Site Year 4 of construction in relation to construction river traffic.

12.4.120 There are no known proposals to change the pedestrian or cycle network by Site Year 2 of construction and it is assumed that the network will continue to operate as indicated in the baseline situation. The LoS on the surrounding pedestrian network would remain as indicated in the baseline situation, with sufficient capacity and no obstructions to movements.

12.4.121 In terms of the public transport network, it is expected that as a result of the TfL London Underground Upgrade Plan(TfL, 2011)[7], compared to the current baseline, London Underground capacity will increase by approximately 24% on the District Line. The TfL Upgrade Plan envisages a combined increase in capacity on the Circle and Hammersmith and City Line of 65% although it is clear that a significant proportion of this increase is attributed to the revised service patterns implemented in 2009, which will already be reflected in the baseline data. It is envisaged that London Underground and National Rail patronage will also increase by Site Year 2 of construction.

12.4.122 In order to ensure that a busiest base case scenario has been used in assessing the result of additional construction worker journeys by public transport, the capacity for public transport services in the construction base case has been assumed to remain the same as capacity in the baseline situation. This ensures a robust assessment as outlined in Volume 2.

12.4.123 There are no known current proposals to alter river passenger services, pier locations or river navigation patterns from the current baseline conditions and therefore the construction base case in Site Year 4 of construction remains similar to the baseline position.

12.4.124 Baseline traffic flows (from the junction surveys and TfL models) have been used and forecasting carried out to understand the capacity on the highway network in the vicinity of the Blackfriars Bridge Foreshore site in Site Year 2 of construction without the Thames Tideway Tunnel project. The construction base case traffic flows (derived from the survey data) which provide input to the LinSig model are shown on Vol 18 Figure 12.4.6 and Vol 18 Figure 12.4.7 (see separate volume of figures).

12.4.125 The LinSig models have been used to understand the operation of the junctions outlined in para. 12.3.7 in the construction base case. A summary of the results for the weekday AM and PM peak hours is presented in Vol 18 Table 12.5.3 and Vol 18 Table 12.5.4.

12.4.126 The construction base case model shows that the junction of Blackfriars Bridge Road (A201) and Victoria Embankment (A3211) westbound slip road will operate at capacity in the AM peak hour and below capacity in the PM peak hour. The overall junction delay will be 20 PCU hours in the AM peak hour and 16 PCU hours in the PM peak hour.

12.4.127 The junction of Victoria Embankment (A3211) and Temple Avenue will operate above capacity in the AM peak hour and at capacity in the PM peak hour and the overall junction delays will be 32 and 21 seconds per vehicle respectively.

12.4.128 The junction of Blackfriars Bridge Road (A201), New Bridge Street (A201) and Queen Victoria Street will operate above capacity in the AM and PM peak hours and the overall junction delays will be 68 and 108 seconds per vehicle respectively.

12.4.129 The junctions of Queen Victoria Street / Puddle Dock and Upper Thames Street (A3211) / Puddle Dock / Blackfriars Passage will operate within capacity in the AM and PM peak hours. The overall junction delays at the Queen Victoria Street / Puddle Dock junction will be ten and nine seconds per vehicle in the AM and PM peak hour respectively. For the junction of Upper Thames Street (A3211) / Puddle Dock / Blackfriars Passage, the overall junction delays will be 23 and seven seconds per vehicle in the AM and PM peak hour respectively.

12.4.130 Of the new developments detailed in the site development schedule (Vol 18 Appendix N), only one is relevant as a receptor to the Transport Assessment being within 250m of the Blackfriars Bridge Foreshore site. This is the development of the Mermaid Theatre as detailed in Vol 18 Table 12.4.3 on the basis that impacts could be experienced by staff and visitors using the footways and local highway network in the vicinity of the site.

Vol 18 Table 12.4.3 Transport – construction base case additional receptors

Receptors (relating to developments within 250m of the site)	Phase at which receptor is sensitive to identified impacts	Value/sensitivity and justification
Staff and visitors at Mermaid Theatre development	Construction	High sensitivity to increases in HGV traffic and changes to pedestrian environment and highway layout changes including highway capacity modifications resulting in journey time delays

Operational base case

12.4.131 The operational assessment year for transport is Year 1 of operation.

12.4.132 As explained in paras. 112.2.28 to 12.2.29, the elements of the transport network considered during the operational assessment are pedestrian routes and highway layout and operation. Operators and passengers using Blackfriars Millennium Pier could also be affected by the proposed permanent relocation of Blackfriars Millennium Pier.

12.4.133 For the purposes of the operational base case, it is anticipated that the highway layout will be as described in the construction base case. Similarly, the operational assessment has been based on the pedestrian routes that are set out for the construction base case.

12.4.134 The operational base case, Year 1 of operation, takes into account the developments described in the site development schedule (see Vol 18 Appendix N). The development of the Mermaid Theatre which is within 250m of the Blackfriars Bridge Foreshore site would be complete and operational by Year 1 of operation. However, given infrequent and short-term nature of maintenance activity and the site and the limited effects which are anticipated in the operational phase, this development does not present an additional transport receptor that requires consideration in the operational effects assessment.

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 Blackfriars Bridge Foreshore site (Site Year 2 of construction for construction road traffic and Site Year 4 of construction for construction river traffic).

12.5.2 The anticipated mode split of worker trips (covering all types of construction worker as set out in Vol 18 Table 12.2.2) for the Blackfriars Bridge Foreshore site is detailed in Vol 18 Table 12.5.1 and has been generated based on 2001 Census data for journeys to workplaces within the vicinity of the Blackfriars Bridge Foreshore site[iv]. This shows that the predominant mode of travel for construction workers would be 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 to a maximum of four hours, and measures to reduce car use would be incorporated into site-specific *Travel Plan*, it is highly unlikely that workers would travel by car. The Census mode shares have therefore been adjusted to reflect increased levels of non-car use by workers at this site. This forms the basis of the assessment.

[iv] Based on 2001 Census as this type of data had not been released from the 2011 Census at the time of assessment.

Vol 18 Table 12.5.1 Transport – mode split

Mode	Percentage of trips to site	Equivalent number of worker trips (based on 70 worker trips)	
		AM peak hour (07:00-08:00)	PM peak hour (18:00-19:00)
Bus	7%	5	5
National Rail	48%	34	34
Underground	38%	27	27
Car driver	<1%*	0	0
Car passenger	<1%*	0	0
Cycle	2%	1	1
Walk	3%	2	2
River	0%	<1	<1
Other (taxi/motorcycle)	2%	1	1
Total	100%	70	70

** Assumed to be zero for the purposes of the assessment.*

Pedestrian routes

12.5.4 The Thames Path runs along Paul's Walk and the southern footway of Victoria Embankment (A3211) and it would require closure and diversion as a result of the construction works. This would be necessary throughout the construction works.

12.5.5 The pedestrian route would be diverted from Paul's Walk up to Blackfriars Bridge Road (A201) using the existing staircase on the eastern side of the bridge. A new lift would provide step-free access for pedestrians along the same route. All pedestrians would then use the at-grade crossing points on Blackfriars Bridge (A201) to reach the footway on the Victoria Embankment (A3211) eastbound off-slip road, on the north side of Victoria Embankment (A3211). Pedestrians would then walk along Victoria Embankment (A3211) and would be able to cross back to the southern footway at the pedestrian crossing at the junction of Temple Place. The pedestrian crossing at the junction of Victoria Embankment (A3211) and Temple Avenue would be suspended during the construction works.

12.5.6 The construction phase – phase 1-4 and the Blackfriars Pier relocation plans (see separate volume of figures – Section 1) show the changes to the pedestrian footways during construction.

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 70 worker trips generated by the site have been added to the construction base case pedestrian flows during the AM and PM peak hours.

12.5.8 The relocation of Blackfriars Millennium Pier would also change pedestrian routes and demands in the area. The assessment has considered the operation of Paul's Walk, which would provide the access route to the relocated pier. It takes account of existing pedestrian flows, together with the flows associated with passengers boarding and alighting from vessels at the pier. Taking into consideration the pedestrian diversions and increase in worker trips, additional demand would be placed on the northern footway of Victoria Embankment (A3211), the at-grade crossings of the Blackfriars Bridge (A201) junction and the staircase to Paul's Walk. The analysis shows that pedestrian LoS values would therefore change from those in the construction base case. The northern footway of Victoria Embankment (A3211) would operate at LoS C, an acceptable level of pedestrian movements. This means that the existing footway widths, crossing points and staircase on Paul's Walk are of sufficient capacity to accommodate the additional pedestrian flow.

12.5.9 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 Volume 2).

12.5.10 It is anticipated that the pedestrian diversions around the Blackfriars Bridge Foreshore main site would result in a worst case journey time increase of approximately three minutes, due to the four additional crossings and extension of the journey by 70m, based on a walking speed of 1.3m/sec. This results in a medium adverse impact on pedestrian delay, for those walking along the southern side of Victoria Embankment (A3211).

12.5.11 Other pedestrian movements in the area, such as those using the northern footway of Victoria Embankment (A3211), or using Blackfriars Bridge to access New Bridge Street and Queen Victoria Street would experience a negligible impact on pedestrian delay.

12.5.12 With regards to pedestrian amenity and accidents and safety, the closure of the southern Victoria Embankment (A3211) footway would result in pedestrians having to make an additional four road crossings. The impact magnitudes for pedestrian amenity and accidents and safety would therefore be classified as high adverse using the criteria set out in Volume 2.

Cycle facilities and routes

12.5.13 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 Volume 2).

12.5.14 Cyclists using the highway would experience an additional delay to journey times as a result of the construction works at the Blackfriars Bridge Foreshore site, either due to changes in delay at junctions or due to a diversion route being in place. The effect on journey times is outlined under the highway operation and network assessments (paras. 12.5.60 to 12.5.64).

12.5.15 During Phases 1 and 2 of construction, there would be a potential increase of up to 31 seconds in the AM peak hour over that in the construction base case for cyclists using the northbound carriageway of Blackfriars Bridge Road (A201) at the junction of Blackfriars Bridge Road (A201) and Victoria Embankment (A3211) westbound slip road. This represents a negligible impact. In the PM peak hour there would be no change in delay for cyclists at this junction during these phases of construction.

12.5.16 Cyclists going south using the New Bridge Street (A201) southbound approach turning into the westbound ramp would experience a potential increase in journey time of eight seconds in the AM peak hour, which equates to a negligible impact. In the PM peak hour delays would increase by up to 58 seconds at this junction. Cyclists on other routes would experience a negligible impact on cycle delay.

12.5.17 During phase 3 of the construction, cyclists going north using the nearside lane of Blackfriars Bridge Road (A201) to get to New Bridge Street (A201) would experience a similar journey time to that in phases 1 and 2. This represents a negligible impact. Cyclists on other routes would also experience a negligible impact on cycle delay

12.5.18 These are the delays produced by the LinSig modelling and indicate the level of potential delay to cyclists; however, in practice cyclists are unlikely to experience delays of this magnitude due to the presence of cycle lanes and advance stop lines on the approaches to the junctions, the potential for cyclists to use alternative routes or to dismount and walk past congested approaches.

12.5.19 A specific impact on cyclists during Phase 3 of construction would be caused by the closure of the westbound Victoria Embankment (A3211) slip road. This would require cyclists to use the diversion routes either north and west via Fleet Street and Arundel Street, or south and east via Southwark Street (A3200) and Southwark Bridge (A300). These diversion routes are shown on Vol 18 Figure 12.5.1 (see separate volume of figures). Cyclists using the diversion route via Fleet Street would experience an increase in journey time of approximately five minutes. Those using the route via Southwark Street would experience an increase in journey time of approximately six minutes and 15 seconds.

12.5.20 With regard to accidents and safety, there would be an increase in construction traffic flow of between four and 20 two-way HGV movements per hour. However, as the site access would be directly on to the TLRN there would be a medium adverse impact on cyclists.

Bus routes and patronage

12.5.21 Routes 63, 100, 45, N63, N89 and N550 run through the junction of Blackfriars Bridge (A201) / New Bridge Street (A201) / Queen Victoria Street. None of the services exit using the westbound on-slip road to access the Victoria Embankment (A3211).

12.5.22 During Phases 1 and 2 of the construction works the westbound slip road would remain open to all vehicles. However, additional construction vehicles serving the site may affect some bus routes and bus journey times that travel through the Blackfriars Bridge (A201) / New Bridge Street (A201) / Queen Victoria Street junction and the wider area. The effect on journey times is detailed under the highway operation and network assessment (paras. 12.5.60to 12.5.64) when there would be an increase of 31 seconds over that in the construction base case for bus services using the northbound carriageway of Blackfriars Bridge Road (A201) at the junction of Blackfriars Bridge Road (A201) and Victoria Embankment slip road. This represents a negligible impact. In the PM peak hour there would be no change in delay for bus users at this junction during these phases of construction. Buses using other routes would experience a lesser impact on bus delay.

12.5.23 During Phase 3 of the construction works, the westbound slip road would be closed to all traffic. The effect on journey times in Phase 3 is detailed under the highway operation and network assessment (paras. 12.5.60to 12.5.64) when there would be a similar journey time as to that in phases 1 and 2 for bus routes using the Blackfriars Bridge (A201) / New Bridge Street (A201) / Queen Victoria Street junction. This represents a negligible impact.

12.5.24 It is expected that approximately five 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 approximately 220 buses per hour within a 640m walking distance during the AM and PM peak hours).

12.5.25 Based on the impact criteria outlined in Volume 2, the additional worker trips made by bus in peak hours would have a negligible impact on bus patronage.

London Underground and National Rail and patronage

12.5.26 No underground or rail stations are directly adjacent to the site and therefore none would be directly affected by the construction site development. It is anticipated that approximately 27 construction workers and labourers would use London Underground services and 34 would use National Rail services to access the site.

12.5.27 This would result in less than one additional person trip per train on London Underground Circle and District Line services via Temple or Blackfriars, based on an average of 55 services per hour in total in each peak hour. On National Rail, the additional demand represents approximately one additional passenger per train based on a total of 28 and 26 services per hour at Blackfriars station in the AM and PM peak hours respectively.

12.5.28 Based on the quantitative assessment of patronage and the impact criteria on rail patronage in Volume 2, this would result in a negligible impact on National Rail and London Underground services.

River passenger services and patronage

12.5.29 To facilitate construction works, the President, a permanently moored restaurant/pub boat, would be temporarily relocated at Chrysanthemum

Pier to the west of the construction site. Blackfriars Millennium Pier would also be permanently relocated to the east side of Blackfriars rail Bridge.

12.5.30 In determining the magnitude of impacts on patrons of the moored vessel and Blackfriars Millennium Pier, the relevant impact criteria are pedestrian delay and pedestrian amenity which are described in paras. 12.5.10 and 12.5.12. This indicates a medium adverse impact on pedestrian delay and a high adverse impact on pedestrian amenity due to the additional distance and additional road crossings that pedestrians are required to make.

12.5.31 In terms of impact on operators of the President and Blackfriars Millennium Pier, the relevant impact criterion is parking and loading which are discussed in paras. 12.5.41 to 12.5.47. This describes a negligible impact on on-street car parking and a negligible impact on loading bays.

12.5.32 During construction, river passenger services would also be affected by the relocation of the Blackfriars Millennium Pier. For operators, the relevant assessment criteria are those for river navigation and access and these are discussed in paras. 12.5.34 to 12.5.40 below. This indicates a low adverse impact on river navigation.

12.5.33 It is anticipated that very few construction workers would use the river services to access the construction site in each peak hour. In accordance with the impact criteria for river patronage set out in Volume 2, this would result in a negligible impact on river passenger service patronage.

River navigation and access

12.5.34 The section addresses the effects on river navigation and access in the vicinity of the Blackfriars Bridge Foreshore site. The wider effects of transporting construction materials by river from a number of sites within the project are dealt with in Volume 3.

12.5.35 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 be within Site Year 4 of construction with a daily average of six barge movements a day.

12.5.36 Barges would be hauled by tugs which typically haul two barges at a time where possible. The number of transit movements required on the river may therefore be lower than the number of individual barge movements.

12.5.37 It is noted that a separate *Navigational Issues and Preliminary Risk Assessment* that has been undertaken for the permanent structures and temporary construction works and barges to be used at the Blackfriars Bridge Foreshore site. This is reported separately outside of the *Environmental Statement* and the *Transport Assessment* in the documents that accompany the application

12.5.38 Based on the mooring impact criteria for river navigation and access as outlined in Volume 2, the impact on the operator of the President would be low due to its relocation to Chrysanthemum Pier. In terms of the criteria set out in Volume 2 for river navigation and access impacts, in the context of the transport assessment, the impact of the relocation of the President has been assessed as low adverse (in relation to changes in number of vessel movements and moorings).

12.5.39 The relocation of Blackfriars Millennium Pier would also require changes to the way in which river passenger vessels access the pier, and may also affect navigational requirements for other vessels passing this location.

12.5.40 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 Blackfriars Bridge Foreshore would be negligible.

Parking

12.5.41 Victoria Embankment (A3211) does not have any on-street car parking available due to TLRN restrictions in the area in the immediate vicinity of the site. Therefore, there would be no direct impact on on-street car parking or private parking in the vicinity of the site as a result of the construction works. This lack of parking in the vicinity also means that construction workers would not drive to the site meaning that there would be no impact on local parking from construction workers.

12.5.42 However, to enable construction vehicles to access the site from the westbound slip road in Phases 1 and 2 and as a result of the closure of the slip road in Phase 3, two coach parking bays on the westbound Blackfriars Bridge (A201) exit slip road would require suspension for the duration of the construction works at the Blackfriars Bridge Foreshore site. Two bays would be provided on Blackfriars Road (A201) approximately 450m to the south of the Blackfriars Bridge Foreshore site. TfL and the City of London Corporation have agreed in principle the suspension and reprovision of these two coach parking bays.

12.5.43 The loading bay on the westbound Blackfriars Bridge (A201) exit slip road, to the east of the coach parking bays would also be suspended during the construction works. A loading bay would be located on White Lion Hill approximately 300m to the east of the Blackfriars Bridge Foreshore site and be utilised during this period. TfL and the City of London Corporation have agreed in principle the suspension and reprovision of the bay.

12.5.44 The highway layout during construction plans (see separate volume of figures – Section 1) show the proposed suspension of coach parking and loading bays and the locations of the temporary provision associated with the construction works at the Blackfriars Bridge Foreshore site.

12.5.45 In determining the magnitude of impacts, the relevant criteria are vehicle parking and loading changes (as set out in Volume 2).

12.5.46 Due to the suspension of the coach parking bays during construction and the nearest alternative bays being either approximately 400m west or 450m south from the existing location, this equates to a medium adverse impact.

12.5.47 The reprovision of the loading bay would give rise to a negligible impact as the new loading bay is situated a similar distance from the relocated pier site as the original loading bay.

Highway network and operation

12.5.48 The highway layout during construction plans (see separate volume of figures – Section 1)) show the highway layout during all phases of the construction at the Blackfriars Bridge Foreshore site.

12.5.49 During Phases 1 and 2 there would be a gated site access along the westbound exit ramp of Victoria Embankment (A3211) for the left-turn in / left turn out movements of construction vehicles. To accommodate construction vehicles arriving at and departing from the site, the carriageway width of the westbound exit ramp would be reduced; however, a minimum width of 3.25m would be maintained.

12.5.50 In Phase 3 of construction the westbound exit ramp would be closed to all traffic. In this phase, there would be a gated site access for left turn in / left turn out for construction vehicles from the westbound carriageway of Blackfriars Underpass (A3211). Signed diversion routes for traffic would be in place.

12.5.51 The highway layout during construction vehicle swept path analysis (see Blackfriars Bridge Foreshore *Transport Assessment* figures) demonstrates that the construction vehicles would be able to safely enter and leave the site during all phases of construction.

12.5.52 Construction lorry movements would be limited to the day shift only (08:00 to 18:00 Monday to Friday and 08:00 to 13:00 Saturday). For the period of extended hours for diaphragm wall construction concrete deliveries would be undertaken up to 22.00 approximately two times a week. It is only then 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 on agreement with the City of London Corporation.

12.5.53 Vol 18 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 desirable to reduced 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*.

Vol 18 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%*	92	0	9	9	0
Other construction vehicle movements**	36	4	4	4	4
Worker vehicle movements***	nominal	0	0	0	0
Total	**128**	**4**	**13**	**13**	**4**

** The assessment has been based on 10% of the daily construction lorry vehicle movements associated with materials would 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 (see Vol 18 Table 12.5.1), on the basis that there would be no worker parking on site; on-street parking in the area restricted; and site-specific Travel Plan measures would discourage workers from driving. In practical terms, this would be close to zero.*

12.5.54 To ensure the assessment of the highway network is robust it has been based on a combination of the peak hour of movements for construction lorries and other construction vehicles between 07:00 and 09:00 and 17:00 and 19:00. These have been combined and applied to the peak hour to take into account the highest number of movements generated by the site.

12.5.55 An average peak flow of 128 vehicle movements a day is expected during the months of greatest activity during Site Year 2 at this site. At other times in the construction period, vehicle flows would be lower than this average peak figure.

12.5.56 The relevant impact 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 Volume 2).

12.5.57 Changes would be made to the highway layout and the site access would be directly to/from the TLRN. There would be an additional nine two-way HGV movements per hour as a result of the construction at Blackfriars Bridge Foreshore, plus two HGV movements during the peak hour associated with other Thames Tideway Tunnel project sites passing along Victoria Embankment (A3211) during Site Year 2 of construction at the Blackfriars Bridge Foreshore site. This would result in a medium adverse impact on accidents and safety.

12.5.58 It is assessed that potentially one hazardous load would be travelling to and from this site per fortnight. This equates to a low adverse impact.

12.5.59 The local LinSig model has been used to apply the construction traffic 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 with the phase 1/2 and phase 3 development cases). The development case traffic flows (providing input to the LinSig model) are shown on Vol 18 Figure 12.4.6 and Vol 18 Figure 12.4.7 (see separate volume of figures).

12.5.60 A summary of the construction assessment results for the weekday AM and PM peak hours is presented in Vol 18 Table 12.5.3 and Vol 18 Table 12.5.4 for Phases 1 and 2. Vol 18 Table 12.5.5 and Vol 18 Table 12.5.6 present a summary of the results for Phase 3 in the weekday AM and PM peak hours respectively.

12.5.61 In Phases 1 and 2, the construction traffic generated in the construction development case would produce an increase in traffic demand at the junctions of Blackfriars Bridge Road (A201) / Victoria Embankment (A3211) westbound slip road, Victoria Embankment (A3211) / Temple Avenue, and Blackfriars Bridge Road (A201) / New Bridge Street (A201) / Queen Victoria Street in the AM peak hour. There would be a maximum increase in delay of 31 seconds per vehicle over that in the construction base case along the northbound carriageway of Blackfriars Bridge Road (A201) at the junction of Blackfriars Bridge Road (A201) / Victoria Embankment (A3211) westbound slip road. This represents a negligible impact.

12.5.62 In the PM peak hour, there would be a small change to the overall junction capacity at the junctions. The maximum delay of 58 seconds per vehicle would be experienced along New Bridge Street (A201) at the junction with Blackfriars Bridge Road (A201) / Queen Victoria Street. This represents a negligible impact.

12.5.63 The construction traffic and highway layout changes in the Phase 3 construction development case would also produce a change in vehicle movements and operation of the junctions. The overall operation of the junctions outlined in para. 12.3.7 would generally improve in the AM and PM peak hours despite the additional construction traffic. This is due to the closure of the westbound Victoria Embankment (A3211) slip road and traffic diversion routes to Fleet Street and Arundel Street, or Southwark Street (A3200) and Southwark Bridge (A300). This represents a negligible impact.

12.5.64 Although the overall average delay at these junctions would decrease in Phase 3 of construction, some movements would still experience additional delay with the maximum delay to journey time in the AM peak hour of 11 seconds over that in the construction base case along New Bridge Street (A201) at the junction with Blackfriars Bridge Road (A201) / Queen Victoria Street. In the PM peak hour, the maximum delay of 12 seconds per vehicle would be experienced at the Queen Victoria Street / Puddle Dock junction on Puddle Dock. This represents a negligible impact.

Vol 18 Table 12.5.3 Transport – construction LinSig model outputs (AM peak hour) – Phases 1 and 2

Approach	Arm	Flow	Weekday								
			AM peak hour (08:00-09:00)								
			DoS			MMQ (PCUs)			Delay per PCU (seconds)		
			Base case	Devt case	Change	Base case	Devt case	Change	Base case	Devt case	Change
Junction of Blackfriars Bridge Road (A201) / Victoria Embankment (A3211) westbound slip road											
Blackfriars Bridge Road (A201) - northbound	Ahead / left	1004	90%	98%	+10	26	36	+10	32	61	+31
	Ahead	487	44%	48%	+3	8	9	+1	14	17	+3
Blackfriars Bridge Road (A201) southbound, to Victoria Embankment	Right	333	25%	20%	-5	1	1	-	1	2	+1
Victoria Embankment (A3211) - eastbound slip-road	Ahead (nearside lane)	257	85%	60%	-25	10	7	-3	61	39	-22
	Ahead (offside lane)	177	39%	41%	+2	4	5	+1	36	34	-2
			PRC						**Total delay (PCU hours)**		
Overall junction performance			+1%	-9%	-10				20	29	+9
Junction of Victoria Embankment (A3211) / Temple Avenue											
Victoria Embankment (A3211) - eastbound	Ahead (nearside lane)	1129	99%	97%	-2	41	37	+11	58	48	+10
	Ahead (offside	873	76%	75%	-1	17	16	-1	17	17	-

Approach	Arm	Flow	Weekday								
			AM peak hour (08:00-09:00)								
			DoS			MMQ (PCUs)			Delay per PCU (seconds)		
			Base case	Devt case	Change	Base case	Devt case	Change	Base case	Devt case	Change
	lane)										
Victoria Embankment (A3211) - westbound	Ahead (nearside lane)	265	21%	21%	-	2	2	-	4	4	-
	Ahead (offside lane)	330	21%	26%	+5	2	2	-	4	4	-
	Ahead (offside lane)	833	71%	71%	-	15	14	-1	15	15	-
Temple Avenue	Right	78	19%	19%	-	2	2	-	32	32	-
			PRC						Total delay (PCU hours)		
Overall junction performance			-10%	-8%	+2				32	28	-4
Junction of Blackfriars Bridge Road (A201), New Bridge Street (A201) / Queen Victoria Street											
Blackfriars Bridge Road (A201) - northbound	Ahead (nearside lane)	730	66%	65%	+1	16	7	-9	22	10	-12
	Ahead (offside lane)	704	68%	62%	-6	13	10	-3	23	7	-16
	Right	471	90%	90%	-	14	13	-1	57	55	-2
New Bridge Street (A201)	Ahead	478	84%	92%	+8	14	14	-	48	48	-
	Ahead	608	107%	107%	-	41	43	+2	189	197	+8
Queen Victoria	Left	324	97%	99%	+2	15	15	-	106	119	+13

Approach	Arm	Flow	Weekday								
			AM peak hour (08:00-09:00)								
			DoS			MMQ (PCUs)			Delay per PCU (seconds)		
			Base case	Devt case	Change	Base case	Devt case	Change	Base case	Devt case	Change
Street	Left / right	207	64%	71%	+7	6	7	+1	46	51	+5
			PRC						Total delay (PCU hours)		
Overall junction performance			-18%	-19%	-1				68	64	-4
Junction of Queen Victoria Street / Puddle Dock											
Queen Victoria Street -eastbound	Ahead	229	31%	39%	+8	2	3	+1	10	12	+2
	Ahead / right	242	42%	42%	-	3	4	+1	11	13	+2
Queen Victoria Street -westbound	Ahead	140	38%	40%	+2	4	4	-	39	42	+3
	Ahead / left	169	46%	48%	+2	5	5	-	40	43	+3
Puddle Dock	Right / left	465	52%	51%	-1	6	6	-	23	32	+9
	Right	264	46%	49%	-3	6	7	+1	28	35	+7
			PRC						Total delay (PCU hours)		
Overall junction performance			73%	76%	+3				10	12	+2
Junction of Upper Thames Street (A3211) / Puddle Dock / Blackfriars Passage											
Upper Thames Street (A3211) - eastbound	Ahead / left	731	57%	62%	+5	5	6	+1	7	7	-
	Ahead	873	64%	70%	+6	5	10	+5	6	8	+2
Upper Thames Street (A3211) -	Right	353	106%	74%	-32	23	9	-14	207	46	-161

Approach	Arm	Flow	Weekday								
			AM peak hour (08:00-09:00)								
			DoS			MMQ (PCUs)			Delay per PCU (seconds)		
			Base case	Devt case	Change	Base case	Devt case	Change	Base case	Devt case	Change
westbound											
Blackfriars Passage	Ahead	236	40%	40%	-	1	1	-	5	5	-
			PRC						Total delay (PCU hours)		
Overall junction performance			-18%	22%	+40				23	9	-14

Notes: 1. DoS represents Degree of Saturation; the ratio of flow to capacity. MMQ represents Mean Maximum Queue for the busiest-case 15 minute modelled period (in vehicle lengths). PRC represents overall Practical Reserve Capacity; measure of how much additional traffic could pass through a junction whilst maintaining a maximum DoS of 90% on all lanes. Delay represents the mean delay per PCU. PCU value for a car is one PCU. Vans and three-axle vehicles are 1.5 PCUs, vehicles with fout or more axles are 2.3PCUs. Buses and coaches are two PCUs. Motorcycles and pedal cycles are 0.4 PCUs. Thames Tideway Tunnel construction vehicles would be a mixture of three- and four-axle vehicles and have therefore been given a PCU value of two.
2. Assessment has assumed that traffic signal optimisation has been undertaken as detailed in para. 12.3.20.

Vol 18 Table 12.5.4 Transport – construction LinSig model outputs (PM peak hour) – Phases 1 and 2

Approach	Arm	Flow	Weekday								
			PM peak hour (17:00-18:00)								
			DoS			MMQ (PCUs)			Delay per PCU (seconds)		
			Base case	Devt case	Change	Base case	Devt case	Change	Base case	Devt case	Change
Junction of Blackfriars Bridge Road (A201) / Victoria Embankment (A3211) westbound slip road											
Blackfriars Bridge Road (A201) - northbound	Ahead / left	611	82%	80%	-2	16	16	-	38	36	-2
	Ahead	342	46%	45%	-1	7	7	-	26	25	-1
Blackfriars Bridge Road (A201) southbound, to Victoria Embankment	Right	334	31%	29%	-2	1	1	-	2	1	-1
Victoria Embankment (A3211) - eastbound slip-road	Ahead (nearside lane)	314	50%	48%	-2	6	6	-	37	32	-5
	Ahead (offside lane)	133	24%	20%	-4	3	3	-	32	19	-13
			PRC						Total delay (PCU hours)		
Overall junction performance			10%	13%	-3				16	14	-2
Junction of Victoria Embankment (A3211) / Temple Avenue											
Victoria Embankment (A3211) - eastbound	Ahead (nearside lane)	1065	90%	92%	+2	26	28	+2	27	30	+3
	Ahead (offside lane)	787	66%	68%	+2	13	13	-	14	14	-

Approach	Arm	Flow	Weekday								
			PM peak hour (17:00-18:00)								
			DoS			MMQ (PCUs)			Delay per PCU (seconds)		
			Base case	Devt case	Change	Base case	Devt case	Change	Base case	Devt case	Change
Victoria Embankment (A3211) - westbound	Ahead (nearside lane)	382	27%	27%	-	4	4	-	9	7	-2
	Ahead (offside lane)	757	63%	64%	+1	12	12	-	13	13	-
	Ahead (offside lane)	758	64%	64%	-	12	12	-	13	13	-
Temple Avenue	Right	136	33%	32%	-1	3	3	-	34	34	-
			PRC						Total delay (PCU hours)		
Overall junction performance			1%	-2%	-3				21	22	-+1
Junction of Blackfriars Bridge Road (A201) / New Bridge Street (A201) / Queen Victoria Street											
Blackfriars Bridge Road (A201) - northbound	Ahead (nearside lane)	812	81%	77%	-4	7	9	+2	13	14	+1
	Ahead (offside lane)	300	28%	30%	+2	1	1	-	5	5	-
	Right	240	97%	96%	-1	12	11	-	120	109	-11
New Bridge Street (A201)	Ahead	731	98%	102%	+4	29	35	+6	82	112	+30
	Ahead	852	114%	118%	+4	82	94	+12	288	346	+58
Queen Victoria Street	Left	423	96%	96%	-	16	16	-	84	83	-1

Approach	Arm	Flow	Weekday								
			PM peak hour (17:00-18:00)								
			DoS			MMQ (PCUs)			Delay per PCU (seconds)		
			Base case	Devt case	Change	Base case	Devt case	Change	Base case	Devt case	Change
	Left / right	263	55%	63%	+8	7	7	-	42	38	-4
			PRC						Total delay (PCU hours)		
Overall junction performance			-27%	-31%	+4				108	128	+20
Junction of Queen Victoria Street / Puddle Dock											
Queen Victoria Street - eastbound	Ahead	17	6%	6%	0%	1	24	23	1	24	23
	Ahead / right	228	54%	54%	0%	9	43	34	9	43	34
Queen Victoria Street - westbound	Ahead	166	19%	19%	0%	2	30	28	2	30	28
	Ahead / left	203	71%	71%	0%	10	41	31	10	41	31
Puddle Dock	Right / left	446	75%	58%	0%	8	8	0	26	26	0
	Right	172	60%	61%	1%	5	5	0	27	27	0
			PRC						Total delay (PCU hours)		
Overall junction performance			34%	65%	+31				9	10	-1
Junction of Upper Thames Street (A3211) / Puddle Dock / Blackfriars Passage											
Upper Thames Street (A3211) - eastbound	Ahead / left	706	54%	57%	+3	4	4	-	7	6	-1
	Ahead	787	61%	60%	-1	5	6	+1	7	6	-1
Upper Thames Street	Right	276	59%	90%	+31	6	11	+5	40	82	+42

Approach	Arm	Flow	Weekday								
			PM peak hour (17:00-18:00)								
			DoS			MMQ (PCUs)			Delay per PCU (seconds)		
			Base case	Devt case	Change	Base case	Devt case	Change	Base case	Devt case	Change
(A3211) - westbound											
Blackfriars Passage	Ahead	271	45%	45%	-	1	1	-	5	6	+1
			PRC						Total delay (PCU hours)		
Overall junction performance			48%	38%	-10				7	7	-

Notes: 1. DoS represents Degree of Saturation; the ratio of flow to capacity. MMQ represents Mean Maximum Queue for the busiest-case 15 minute modelled period (in vehicle lengths). PRC represents overall Practical Reserve Capacity; measure of how much additional traffic could pass through a junction whilst maintaining a maximum DoS of 90% on all lanes. Delay represents the mean delay per PCU. PCU value for a car is one PCU. Vans and three-axle vehicles are 1.5 PCUs, vehicles with fout or more axles are 2.3PCUs. Buses and coaches are two PCUs. Motorcycles and pedal cycles are 0.4 PCUs. Thames Tideway Tunnel construction vehicles would be a mixture of three- and four-axle vehicles and have therefore been given a PCU value of two.

2. Assessment has assumed that traffic signal optimisation has been undertaken as detailed in para. 12.3.20.

Vol 18 Table 12.5.5 Transport – construction LinSig model outputs (AM peak hour) – Phase 3

Approach	Arm	Flow	Weekday								
			AM peak hour (08:00-09:00)								
			DoS			MMQ (PCUs)			Delay per PCU (seconds)		
			Base case	Devt case	Change	Base case	Devt case	Change	Base case	Devt case	Change
Junction of Blackfriars Bridge Road (A201) / Victoria Embankment (A3211) westbound slip road											
Blackfriars Bridge Road (A201) - northbound	Ahead / left	946	90%	83%	-7	26	22	-4	32	25	-7
	Ahead	487	44%	43%	-1	8	8	-	14	13	-1
Blackfriars Bridge Road (A201) southbound, to Victoria Embankment	Right	442	25%	23%	-2	1	1	-	1	1	-
Victoria Embankment (A3211) - eastbound slip-road	Ahead (nearside lane)	257	85%	78%	-7	10	8	-2	61	53	-8
	Ahead (offside lane)	177	39%	54%	+15	4	5	+1	36	39	+3
			PRC						**Total delay (PCU hours)**		
Overall junction performance			+1%	+8%	+7				20	16	
Junction of Victoria Embankment (A3211) / Temple Avenue											
Victoria Embankment (A3211) - eastbound	Ahead (nearside lane)	1129	99%	97%	+2	41	37	-4	58	48	-10
	Ahead (offside	873	76%	75%	-1	17	16	-1	17	17	-

Approach	Arm	Flow	Weekday								
			AM peak hour (08:00-09:00)								
			DoS			MMQ (PCUs)			Delay per PCU (seconds)		
			Base case	Devt case	Change	Base case	Devt case	Change	Base case	Devt case	Change
	lane)										
Victoria Embankment (A3211) - westbound	Ahead (nearside lane)	0	21%	0%	-21	2	0	-2	4	0	-4
	Ahead (offside lane)	672	55%	57%	+2	10	10	-	11	12	+1
	Ahead (offside lane)	912	71%	77%	+6	15	18	+3	15	17	+2
Temple Avenue	Right	78	19%	19%	-	2	2	-	32	32	-
			PRC						Total delay (PCU hours)		
Overall junction performance			-10%	-8%	+2				32	28	-4
Junction of Blackfriars Bridge Road (A201), New Bridge Street (A201) / Queen Victoria Street											
Blackfriars Bridge Road (A201) - northbound	Ahead (nearside lane)	730	66%	66%	-	16	10	-6	22	10	-12
	Ahead (offside lane)	704	68%	63%	-5	13	15		23	12	
	Right	471	90%	83%	-7	14	12		57	43	
New Bridge Street (A201)	Ahead	476	84%	88%	+4	14	14	-	48	59	11
	Ahead	442	107%	95%	-12	41	18	-23	189	80	-109

Approach	Arm	Flow	Weekday								
			AM peak hour (08:00-09:00)								
			DoS			MMQ (PCUs)			Delay per PCU (seconds)		
			Base case	Devt case	Change	Base case	Devt case	Change	Base case	Devt case	Change
Queen Victoria Street	Left	286	97%	92%	-5	15	12	-3	106	78	-28
	Left right	200	64%	64%	-	6	6	-	46	46	-
			PRC						**Total delay (PCU hours)**		
Overall junction performance			-18%	-5%	+13				68	38	-30
Junction of Queen Victoria Street / Puddle Dock											
Queen Victoria Street -eastbound	Ahead	229	31%	38%	+7	2	4	+2	10	12	+2
	Ahead / right	242	42%	41%	-1	3	4	+1	11	12	+1
Queen Victoria Street -westbound	Ahead	140	38%	38%	-	4	4	-	39	40	+1
	Ahead / left	161	46%	43%	+3	5	4	-1	40	41	+1
Puddle Dock	Right / left	440	52%	52%	-	6	6	-	23	32	+9
	Right	264	52%	51%	-1	6	7	+1	28	35	+7
			PRC						**Total delay (PCU hours)**		
Overall junction performance			73%	72%	-1				10	12	+2
Junction of Upper Thames Street (A3211) / Puddle Dock / Blackfriars Passage											
Upper Thames Street (A3211) - eastbound	Ahead / left	575	57%	30%	-27	5	1	-4	7	1	-6
	Ahead	735	64%	39%	-25	5	1	-4	6	2	-4

Approach	Arm	Flow	Weekday								
			AM peak hour (08:00-09:00)								
			DoS			MMQ (PCUs)			Delay per PCU (seconds)		
			Base case	Devt case	Change	Base case	Devt case	Change	Base case	Devt case	Change
Upper Thames Street (A3211) - westbound	Right	328	106%	77%	-29	23	10	-13	207	50	-157
Blackfriars Passage	Ahead	236	40%	40%	-	1	1	-	5	5	-
			PRC						Total delay (PCU hours)		
Overall junction performance			-18%	16%	+34				22	8	-14

Notes: 1. DoS represents Degree of Saturation; the ratio of flow to capacity. MMQ represents Mean Maximum Queue for the busiest-case 15 minute modelled period (in vehicle lengths). PRC represents overall Practical Reserve Capacity; measure of how much additional traffic could pass through a junction whilst maintaining a maximum DoS of 90% on all lanes. Delay represents the mean delay per PCU. PCU value for a car is one PCU. Vans and three-axle vehicles are 1.5 PCUs, vehicles with fout or more axles are 2.3PCUs. Buses and coaches are two PCUs. Motorcycles and pedal cycles are 0.4 PCUs. Thames Tideway Tunnel construction vehicles would be a mixture of three- and four-axle vehicles and have therefore been given a PCU value of two.
2. Assessment has assumed that traffic signal optimisation has been undertaken as detailed in para. 12.3.20.
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Vol 18 Table 12.5.6 Transport – construction LinSig model outputs (PM peak hour) – Phase 3

Approach	Arm	Flow	Weekday								
			PM peak hour (17:00-18:00)								
			DoS			MMQ (PCUs)			Delay per PCU (seconds)		
			Base case	Devt case	Change	Base case	Devt case	Change	Base case	Devt case	Change
Junction of Blackfriars Bridge Road (A201) / Victoria Embankment (A3211) westbound slip road											
Blackfriars Bridge Road (A201) - northbound	Ahead / left	543	82%	53%	-29	16	10	-6	38	18	-20
	Ahead	342	46%	33%	-13	7	6	-1	26	15	-11
Blackfriars Bridge Road (A201) southbound, to Victoria Embankment	Right	643	31%	33%	+2	1	1	-	2	2	-
Victoria Embankment (A3211) - eastbound slip-road	Ahead (nearside lane)	279	50%	65%	+15	6	8	+2	37	38	+1
	Ahead (offside lane)	133	24%	31%	+6	3	3	-	32	30	-2
			PRC						**Total delay (PCU hours)**		
Overall junction performance			13%	39%	+26				16	10	-6
Junction of Victoria Embankment (A3211) / Temple Avenue											
Victoria Embankment (A3211) - eastbound	Ahead (nearside lane)	1064	90%	92%	+2	26	28	+2	27	30	+3
	Ahead (offside lane)	787	66%	68%	+2	13	14	+1	14	14	-

Approach	Arm	Flow	Weekday								
			PM peak hour (17:00-18:00)								
			DoS			MMQ (PCUs)			Delay per PCU (seconds)		
			Base case	Devt case	Change	Base case	Devt case	Change	Base case	Devt case	Change
Victoria Embankment (A3211) - westbound	Ahead (nearside lane)	0	27%	0%	-27	4	0	-4	9	0	-9
	Ahead (offside lane)	757	63%	64%	+1	12	13	+1	13	13	-
	Ahead (offside lane)	860	64%	73%	+9	12	16	+4	13	16	+3
Temple Avenue	Right	136	33%	32%	-1	3	3	-	34	34	-
			PRC						Total delay (PCU hours)		
Overall junction performance			1%	-2%	-3				21	21	-
Junction of Blackfriars Bridge Road (A201), New Bridge Street (A201) / Queen Victoria Street											
Blackfriars Bridge Road (A201) - northbound	Ahead (nearside lane)	777	81%	76%	-5	7	14	+7	13	16	+3
	Ahead (offside lane)	300	28%	29%	+1	1	5	+4	5	10	+5
	Right	280	97%	88%	-9	11	10	-1	120	76	-44
New Bridge Street (A201)	Ahead	609	98%	85%	-13	29	17	-12	82	42	-40
	Ahead	731	114%	102%	-12	82	35	-47	288	112	-176

Approach	Arm	Flow	Weekday								
			PM peak hour (17:00-18:00)								
			DoS			MMQ (PCUs)			Delay per PCU (seconds)		
			Base case	Devt case	Change	Base case	Devt case	Change	Base case	Devt case	Change
Queen Victoria Street	Left	364	96%	92%	-4	16	13	-3	84	71	-13
	Left / right	263	55%	67%	+12	7	8	-1	42	3	-39
			PRC						Total delay (PCU hours)		
Overall junction performance			-27%	-12%	+15				108	50	-58
Junction of Queen Victoria Street / Puddle Dock											
Queen Victoria Street - eastbound	Ahead	228	29%	36%	+7	1	2	+1	8	10	+2
	Ahead / right	17	4%	4%	-	1	1	-	9	11	+2
Queen Victoria Street - westbound	Ahead	166	31%	43%	+12	4	4	-	30	40	+10
	Ahead / left	203	37%	52%	+15	5	5	-	31	42	+11
Puddle Dock	Right / left	421	67%	55%	-12	13	11	+2	24	36	+12
	Right	172	48%	35%	-13	5	4	-1	48	28	-20
			PRC						Total delay (PCU hours)		
Overall junction performance			34%	63%	+29				9	10	+1
Junction of Upper Thames Street (A3211) / Puddle Dock / Blackfriars Passage											
Upper Thames Street	Ahead / left	706	54%	57%	+3	4	5	+1	7	6	-1

Approach	Arm	Flow	Weekday								
			PM peak hour (17:00-18:00)								
			DoS			MMQ (PCUs)			Delay per PCU (seconds)		
			Base case	Devt case	Change	Base case	Devt case	Change	Base case	Devt case	Change
(A3211) - eastbound	Ahead	787	61%	60%	-1	5	7	+2	7	6	-1
Upper Thames Street (A3211) - westbound	Right	251	59%	65%	+6	6	7	+1	40	45	+5
Blackfriars Passage	Ahead	271	45%	45%	-	1	1	-	5	6	+1
			PRC						Total delay (PCU hours)		
Overall junction performance			48%	40%	-8				7	7	-

Notes: 1. DoS represents Degree of Saturation; the ratio of flow to capacity. MMQ represents Mean Maximum Queue for the busiest-case 15 minute modelled period (in vehicle lengths). PRC represents overall Practical Reserve Capacity; measure of how much additional traffic could pass through a junction whilst maintaining a maximum DoS of 90% on all lanes. Delay represents the mean delay per PCU. PCU value for a car is one PCU. Vans and three-axle vehicles are 1.5 PCUs, vehicles with fout or more axles are 2.3PCUs. Buses and coaches are two PCUs. Motorcycles and pedal cycles are 0.4 PCUs. Thames Tideway Tunnel construction vehicles would be a mixture of three- and four-axle vehicles and have therefore been given a PCU value of two.
2. Assessment has assumed that traffic signal optimisation has been undertaken as detailed in para. 12.3.20.

Significance of effects

12.5.65 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 18 Table 12.4.2 and Vol 18 Table 12.4.3.

12.5.66 Vol 18 Table 12.5.7 sets out the effects on each receptor in the vicinity of the site.

Vol 18 Table 12.5.7 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 Paul's Walk and Thames Path Cyclists travelling on roads in the immediate vicinity of the site	Major adverse effect on pedestrians Moderate adverse effect on cyclists	**Pedestrians** • High sensitivity • Medium adverse impact on pedestrian delay • High adverse impact on pedestrian amenity and accidents and safety • Due to majority of impacts of high adverse magnitude, equates to major adverse effect **Cyclists** • High sensitivity • Negligible impact on cycle delay • Medium adverse impact on accidents and safety • Due to negligible and medium adverse impacts with high sensitivity receptor equates to moderate adverse effect
Private vehicle users 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 • Low adverse impact

Receptors (relating to all identified transport effects)	Significance of effect	Justification (receptor sensitivity and impacts)
		from hazardous loads • Due to impacts being of medium, low and negligible magnitude, equates to minor adverse effect **Parking users:** • Low sensitivity • Negligible impact on on-street parking • Due to negligible impact, equates to negligible effect
Emergency vehicles travelling on Victoria Embankment (A3211) and the local highway network	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 impacts being of medium, low and negligible magnitude, with high sensitivity receptor this equates to minor adverse effect
Marine emergency services	Minor adverse effect	• High sensitivity • Low adverse impact from barge movements • Due to low adverse impact, equates to minor adverse effect
Coaches and service vehicles using parking facilities on the westbound Victoria Embankment (A3211) slip road adjacent to the site	Moderate adverse effect on coaches Negligible effect on service vehicles	• High sensitivity • Medium adverse impact on coach parking which equates to moderate adverse effect • Negligible impact on

Receptors (relating to all identified transport effects)	Significance of effect	Justification (receptor sensitivity and impacts)
		loading bays which equates to negligible effect
Bus users (passengers) travelling on routes in the surrounding area	Negligible effect	• Medium sensitivity • Negligible impact on road network delay and patronage • Due to negligible impacts, equates to negligible effect.
River vessel operators	Minor adverse effect	• Medium sensitivity • Low adverse impact from barge movements • Due to low adverse impact, equates to minor adverse effect
Leisure users of the River Thames	Minor adverse effect	• High sensitivity • Low adverse impact from barge movements • Due to low adverse impact, equates to minor adverse effect
Pier operators and passengers using Blackfriars Millennium Pier	Major adverse effect on passengers as pedestrians Negligible effect on pier operators	**River passengers:** • Medium sensitivity • Medium adverse impact on pedestrian delay • High adverse impact on pedestrian amenity and accidents and safety • Due to impacts of high adverse magnitude, equates to major adverse effect **Pier operators:** • Medium sensitivity

Receptors (relating to all identified transport effects)	Significance of effect	Justification (receptor sensitivity and impacts)
		• Negligible impact on on-street parking and loading bays • Due to negligible impacts, equates to negligible effect
Public transport users using rail or river services within the wider area	Negligible effect	• Medium sensitivity • Negligible impact on patronage or services • Due to negligible impact, equates to negligible effect
Kings Bench Walk residents	Major adverse effect on pedestrians Moderate adverse effect on cyclists Minor adverse effect on highway users	**Pedestrians:** • High sensitivity • Medium adverse impact on pedestrian delay • High adverse impact on pedestrian amenity and accidents and safety • Due to majority of impacts of high adverse magnitude, equates to major adverse effect **Cyclists:** • High sensitivity • Negligible impact on cycle delay • Medium adverse impact on accidents and safety • Due to negligible and medium adverse impacts with high sensitivity receptor, equates to a moderate adverse effect. **Highway users:** • Medium sensitivity • Negligible impact on road network delay

Receptors (relating to all identified transport effects)	Significance of effect	Justification (receptor sensitivity and impacts)
		• Medium adverse impact on accidents and safety • Low adverse impact from hazardous loads • Due to impacts being medium, low and negligible magnitude, equates to minor adverse effect
Users of Sion Hall and Audit House Users of specialist sports facility Operators of President Users of Inner Temple Garden Users of buildings 40-60 Victoria Embankment Staff and users of Mermaid Conference Centre Pupils, parents and staff of City of London School Staff and visitors at Mermaid Theatre development	Major adverse effect on pedestrians Moderate adverse effect on cyclists Minor adverse effect on highway users	**Pedestrians:** • High sensitivity • Medium adverse impact on pedestrian delay • High adverse impact on pedestrian amenity and accidents and safety • Due to majority of impacts of high adverse magnitude, equates to major adverse effect **Cyclists:** • High sensitivity • Negligible impact on cycle delay • Medium adverse impact on accidents and safety • Due to negligible and medium adverse impacts, with high sensitivity receptor equates to a moderate 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

Receptors (relating to all identified transport effects)	Significance of effect	Justification (receptor sensitivity and impacts)
		• Due to impacts being medium, low and negligible magnitude, equates to minor adverse effect

Sensitivity test for programme delay

12.5.67 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.

12.5.68 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 or cycle route 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 Blackfriars Bridge 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 18 Appendix N), there would be no new receptors requiring assessment as a result of a one year delay.

12.6 Operational effects assessment

12.6.1 This section summarises the findings of the assessment undertaken for Year 1 of operation at the Blackfriars 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, with certain instances where larger cranes and other associated support vehicles may be required for access to the shaft and tunnel every ten years.

12.6.3 It is proposed that Blackfriars Millennium Pier would be retained in its new location following construction. This would therefore change access to and past the Pier for pedestrians and river vessels, compared to the operational base case.

12.6.4 The operational assessment has taken into consideration those elements that would be affected, which comprise:

a. the short-term impacts on the highway layout and operation when maintenance visits are made to the site

b. the short-term impacts on pedestrian routes when maintenance visits are made to the site

c. the issues for pedestrian movement and river passenger services arising from the proposed repositioning of the Pier

12.6.5 This assessment approach has been discussed with the City of London Corporation and TfL.

Highway layout and operation

12.6.6 During the operational phase, the site would be accessed via Victoria Embankment (A3211) westbound on-slip road from Blackfriars Bridge (A201). The permanent highway layout plan (see separate volume of figures – Section 1) shows the highway layout in the operational phase.

12.6.7 For routine three or six monthly inspections vehicular access would be required for light commercial vehicles, typically a van. On occasion there may also be a need for small flatbed vehicles to access the site.

12.6.8 During ten-yearly inspections, space to locate two large cranes and accompanying support vehicles within the site area would be required. The cranes would facilitate lowering and recovery of tunnel inspection vehicles and to provide duty/standby access for personnel.

12.6.9 To assess the effect of these on the highway layout, swept paths have been undertaken for the largest vehicles including an 11.36m mobile crane, a 10m rigid articulated vehicle and a 10.7m articulated vehicle. The permanent highway layout vehicle swept path analysis plan (see Blackfriars Bridge Foreshore *Transport Assessment* figures) demonstrates that the maintenance vehicles would be able to safely enter and leave the site.

12.6.10 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.

12.6.11 In accordance with the criteria outlined in Volume 2, during the routine inspections of the operational site there would be a negligible impact on road network delay.

12.6.12 Taking into consideration the sensitivities of the receptors affected during the operational phase (pedestrians, private vehicle users, emergency vehicles, operators and passengers using Blackfriars Millennium Pier as identified in Vol 18 Table 12.4.2), this would result in a **negligibl**e effect.

Relocation of Blackfriars Millennium Pier

Pedestrians and passengers

12.6.13 The impacts and effects on river service passengers and pedestrians using Paul's Walk during construction are discussed in paras. 12.5.29 – 12.5.33. During operation of the Thames Tideway Tunnel the lift from Paul's Walk to Blackfriars Bridge would be retained to provide step-free access between the bridge and the riverside walkway.

12.6.14 With the Pier retained in the new location for the operational phase, the impacts would be similar to those which have been identified during construction.

12.6.15 This means that in the operational phase, the effect on river service passengers would be negligible as the interchange distance remains as would be during the construction phase and continue to provide a direct step-free route. The effect on other pedestrians using Paul's Walk would also be **negligible** as the footway width would be maintained and movement along the walkway would not be altered.

River vessels

12.6.16 It is noted that a separate *Navigational Issues and Preliminary Risk Assessment* that has been undertaken for the permanent structures and temporary construction works and barges to be used at the Blackfriars Bridge Foreshore site. There would be no construction barges in the operational phase. In the operational phase the effect on river vessels would therefore be **negligible**.

Sensitivity test for programme delay

12.6.17 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 indicated in the site development schedule (see Vol 18 Appendix N), all of the other developments identified within 1km of the Blackfriars Bridge Foreshore site would be complete and operational by Site Year 2 of construction. This means that there are no specific cumulative effects to assess, although it is noted that the TfL Highway Assignment Models (HAM) have been developed using GLA employment and population forecasts, which are based on the employment and housing projections set out in the *London Plan 2011* . As a result the assessment inherently takes into account a level of future growth and development across London.

12.7.2 Therefore the effects on transport would remain as described in Section 12.5 above. This would also be the case if the programme for the Thames Tideway Tunnel project were delayed by approximately one year.

Operational effects

12.7.3 As indicated in the site development schedule (see Vol 18 Appendix N), all other developments within 1km of the site would be complete and operational by Year 1 of operation and therefore there is no need for a cumulative assessment on transport and the effects would remain as described in Section 12.6 above. 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 Blackfriars Bridge Foreshore site.

12.8.3 During the development of these proposals a range of possible strategies and options has been considered. The measures set out in this section of the *Environmental Statement* 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 as no significant effects are predicted.

12.9 Residual effects assessment

Construction effects

12.9.1 As no mitigation measures are proposed, the residual operational 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 18 Table 12.10.1 Transport – summary of construction assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Pedestrians (including sensitive pedestrians) using Paul's Walk and Thames Path Cyclists travelling on roads in the immediate vicinity of the site	• Loss of footway • Pedestrian diversion routes • Increased journey time for pedestrians and cyclists • Highway layout changes including highway capacity modifications • Movement of large construction vehicles	Major adverse effect on pedestrians Moderate adverse effect on cyclists	None	Major adverse effect on pedestrians Moderate adverse effect on cyclists
Private vehicle users in the area using the local highways or on-street parking	• Movement of large construction vehicles • Highway layout changes including highway capacity modifications • Delay to journey time • Diversions during Phase 3 of construction • No effect on on-street	Minor adverse effect on highway users Negligible effect on on-street parking users	None	Minor adverse effect on highway users Negligible effect on on-street parking users

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
	parking			
Emergency vehicles travelling on Victoria Embankment (A3211) and the local highway network	• Movement of large construction vehicles • Highway layout changes including highway capacity modifications • Delay to journey time • Diversions during Phase 3 of construction	Minor adverse effect	None	Minor adverse effect
Marine emergency services	• Additional barge movements in the vicinity of the Blackfriars Bridge Foreshore site	Minor adverse effect	None	Minor adverse effect
Coaches and service vehicles using parking facilities on the westbound Victoria Embankment (A3211) slip road adjacent to the site	• Suspension of coach parking • Suspension of loading bay	Moderate adverse effect on coaches Negligible effect on service vehicles	None	Moderate adverse effect on coaches Negligible effect on service vehicles
Bus users (passengers) travelling on routes in the surrounding area	• Movement of large construction vehicles • Highway layout changes including	Negligible effect	None	Negligible effect

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
	highway capacity modifications • Delay to journey time • Some additional patronage from construction workers.			
River vessel operators	• Additional barge movements in the vicinity of the Blackfriars Bridge Foreshore site	Minor adverse effect	None	Minor adverse effect
Leisure users of the River Thames	• Additional barge movements in the vicinity of the Blackfriars Bridge Foreshore site	Minor adverse effect	None	Minor adverse effect
Pier operators and passengers using Blackfriars Millennium Pier	• Loss of footway • Pedestrian diversion routes • Increased journey time for pedestrians • Suspension of loading bay	Major adverse effect on passengers as pedestrians Negligible effect on pier operators		Major adverse effect on passengers as pedestrians Negligible effect on pier operators
Public transport users using rail or river services within the area	• Some additional patronage from construction workers	Negligible effect	None	Negligible effect

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Kings Bench Walk residents Users of Sion Hall and Audit House Users of specialist sports facility Operators of President Users of Inner Temple Garden Users of buildings 40-60 Victoria Embankment Staff and users of Mermaid Conference Centre Pupils, parents and staff of City of London School Staff and visitors at Mermaid Theatre development	• Loss of footway • Pedestrian diversion routes • Increased journey time for pedestrians and cyclists • Highway layout changes including highway capacity modifications • Movement of large construction vehicles • Delay to journey time • Diversions during Phase 3 of construction	Major adverse effect on pedestrians Moderate adverse effect on cyclists Minor adverse effect on highway users	None	Major adverse effect on pedestrians Moderate adverse effect on cyclists Minor adverse effect on highway users

Vol 18 Table 12.10.2 Transport – summary of operational assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Pedestrians (including sensitive pedestrians) using Paul's Walk and Thames Path	• Occasional maintenance activity resulting in some temporary, short-term footway interruptions	Negligible effect	None	Negligible effect
Private vehicle users in the area using the local highways or on-street parking	• Occasional delay to road users when large maintenance vehicles accessing site	Negligible effect	None	Negligible effect
Emergency vehicles travelling on Victoria Embankment (A3211) and the local highway network	• Occasional maintenance trips resulting in some temporary, short-term road network delay	Negligible effect	None	Negligible effect
Pier operators and passengers using Blackfriars Millennium Pier	• Relocation of the Blackfriars Millennium Pier increases walking distance for mobility impaired pedestrians and deliveries to the pier	Negligible effect on passengers Negligible effect on river vessels	None	Negligible effect on passengers Negligible effect on river vessels

References

[1] Defra. *National Policy Statement for Waste Water.* (2012)

[2]TfL. *Travel Planning for new development in London*. (2011)

[3] Assessment Tool for Travel plan Building Testing and Evaluation, (ATTrBuTE) is a web based travel planning tool, which ensures that Travel Plans are in accordance with TfL's published guidance on travel planning for new development in London, 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.

[7] TfL. *London Underground Upgrade Plan*. (2011). Available at: http://www.tfl.gov.uk/assets/downloads/corporate/our-upgrade-plan-london-underground-february-2011.pdf

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.18**

Volume 18 Blackfriars Bridge 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 18: Blackfriars Bridge 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 the Blackfriars Bridge Foreshore site.

13.1.2 The proposed development has the potential to affect groundwater due to:

a. dewatering of aquifer units

b. use of grouts/ground treatment to control ingress of water

c. creation of pathways for pollution

d. obstruction to groundwater flows

e. seepages 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 Volume 18 Appendix K and the land quality assessment (see Vol 18 Section 8).

13.1.4 The site is underlain by a secondary aquifer[i] (the upper aquifer) and a principal aquifer[ii] (the lower aquifer), which are separated by a thick layer of London Clay, which is relatively impermeable. No dewatering of the upper aquifer would be required at the site; however, dewatering of the lower aquifer would be required. There are four licensed groundwater abstractions from the Chalk (the lower aquifer) around the Blackfriars site and the external dewatering outside the diaphragm wall[iii] may potentially affect nearby abstraction sources. The dewatering of the lower aquifer at a nearby Thames Tideway Tunnel project CSO drop shaft sites may also influence these abstractions sources.

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).

---

[i] Secondary aquifer – either permeable strata capable of supporting local supplies or low permeability strata with localised features such as fissures (was previously referred to as a minor aquifer).

[ii] Principal aquifer – a geological stratum that exhibits high inter-granular and /or fracture permeability was previously referred to as a major aquifer)

[iii] 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.

13.1.7 Plans of the proposed development as well as figures included in the assessment for this site are contained in a separate volume (Volume 18 Blackfriars Bridge Foreshore Figures).

13.2 Proposed development relevant to groundwater

13.2.1 The proposed development is 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 Blackfriars Bridge Foreshore site, relevant to groundwater, would include:

a. A CSO drop shaft of approximately 24m internal diameter (ID) and approximately 53m deep (or 51.28mATD[iv] based on an assumed ground level of 104.6mATD). The CSO drop shaft would have an approximately 5m thick base slab.

b. An overflow weir chamber on the Northern Low Level Sewer No.1 and an interception chamber on the existing Fleet combined sewer outflow (CSO) under the road bridge.

c. Two connection culverts from the interception chamber and overflow weir chamber to the CSO drop shaft, including a new CSO.

d. New river wall encompassing the above structures

e. A temporary cofferdam 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 summarised in Vol 18 Table 13.2.1 below. Approximate duration of construction and depths are also contained in Vol 18 Table 13.2.1.

Vol 18 Table 13.2.1 Groundwater – methods of construction

Design element	Method of construction	Construction periods (years)*	Construction depth**
CSO drop shaft	Diaphragm wall, dewatering and possible grouting[v]	<1	Deep
Connection to Fleet main CSO	Sheet[vi] or secant piles[vii]	1-2	Shallow

[iv] 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.

[v] 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.

[vi] 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.

Design element	Method of construction	Construction periods (years)*	Construction depth**
outfall, culvert, valve chamber, and new CSO chamber			
Connection to Northern Low Level Sewer No.1, culvert, and valve chamber	Sheet or Secant piles	1-2	Shallow
Tunnel reception and launch	Dewatering to ease the passage of TBM into/out of the CSO drop shaft	<1	Deep
Permanent River wall	Granite faced sheet piles tied to structures behind	<1	Deep
Temporary cofferdam	Sheet pile walls	<1	Deep

** The site would be used for construction purposes for up to 7 years*
*** In terms of construction depth – shallow (means <10m) and deep (>10m).*
New pontoon would involve minimal sub-surface work.

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). Relevant measures included within the *CoCP* Section 8 to ensure adverse effects on groundwater are minimised are as follows:

a. Measures include providing bunded stores for fuel/oils held on site and the settlement of dewatering 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 of water quality monitoring, would be applied to licensed abstractions thought to be at risk.

[vii] 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.

c. Monitoring arrangements for dewatering permits would be developed in liaison with the EA (see also the groundwater monitoring strategy 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 down to avoid the build-up of groundwater on the upstream side of underground structures.

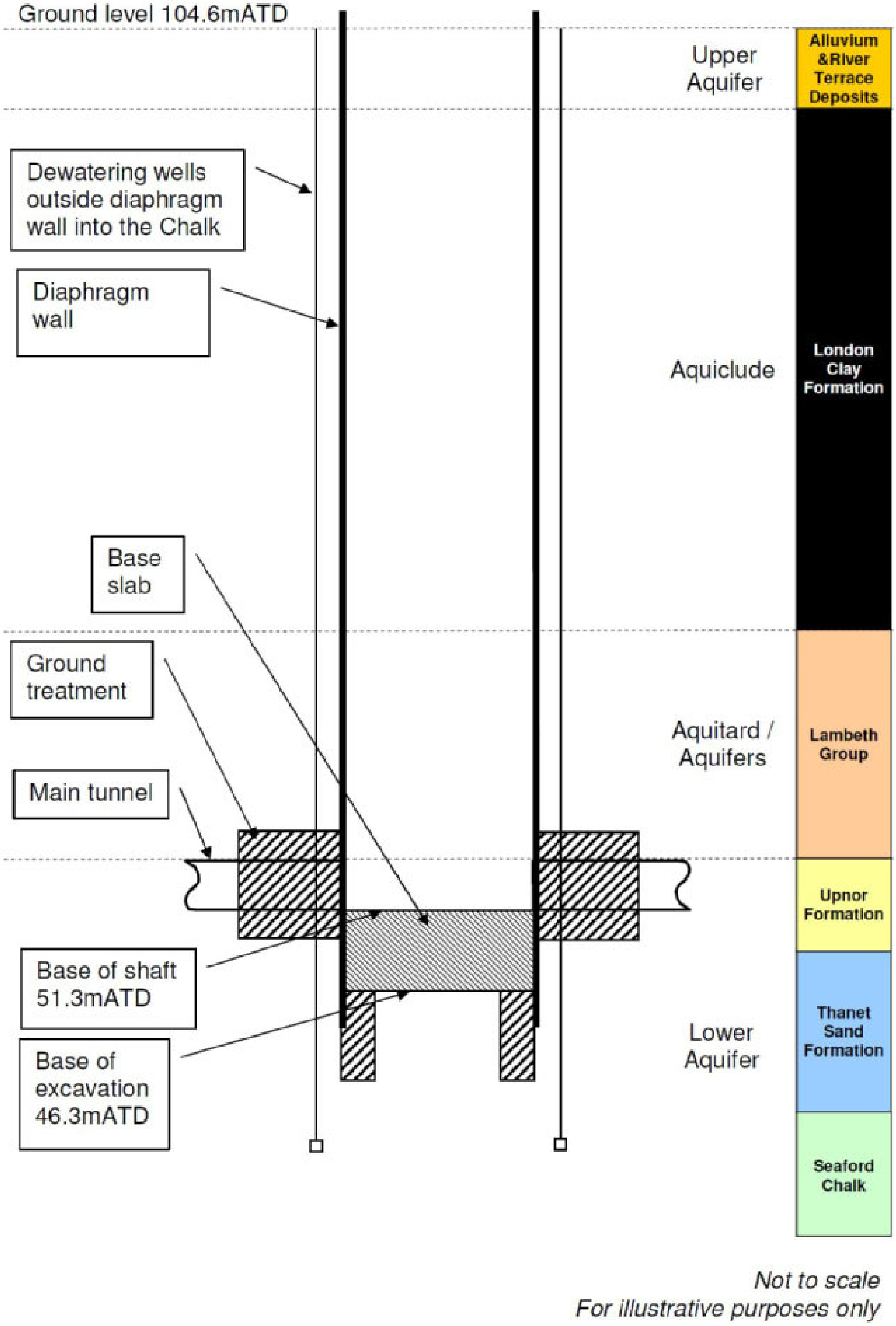
13.2.5 There are no site specific groundwater measures contained within the *CoCP* Section 8.

Other measures during construction

13.2.6 The depth of the CSO drop shaft means that it would extend down into the Upnor Formation (base of the Lambeth Group) and the base slab would extend down into the Thanet Sand Formation (see Vol 18 Table 13.4.1 and Vol 18 Appendix K.1), both of which are expected to contain substantial quantities of groundwater under high pressure.

13.2.7 The drop shaft would be constructed using a diaphragm wall technique. Dewatering wells would be drilled into the Chalk around the outside of the diaphragm wall and pumped to lower the water pressure and under-drain the Thanet Sands (see Vol 18 Plate 13.2.1). The duration of pumping would be determined by ground conditions and groundwater volumes encountered, but is likely to be of the order of up to 29 months, the time required to build and excavate the drop shaft and base slab. Depending on the timing of TBM receipt from Kirtling Street there would then be either a break in dewatering or dewatering would continue to take place. Groundwater would be discharged directly to the river, following any necessary treatment and subject to EA approval.

Vol 18 Plate 13.2.1 Groundwater – schematic of a diaphragm wall, externally dewatered



13.2.8 In order to build the CSO drop shaft, groundwater levels in the Chalk would be reduced from approximately 60mATD to 46mATD, resulting in a design drawdown of approximately 14m. It is estimated the average rate of dewatering needed at Blackfriars Bridge Foreshore site would be approximately 1085m^3/d. This rate is in part due to the transmissivity[viii] of the Chalk at Blackfriars Bridge Foreshore site at around 90m^2/d and the contributory drawdown of dewatering at other sites (see para. 13.3.9).

13.2.9 Dependant on the success of dewatering ground treatment, such as grouting[ix], could be required to further reduce inflows during the construction of the CSO drop shaft and base slab within both the Upnor Formation (of the Lambeth Group) and the Thanet Sands.

13.2.10 In addition, the break into/out of the CSO drop shaft for the tunnel boring machine (TBM) in the main tunnel is expected to require ground treatment around the base of the drop shaft. The dimensions of the two blocks which require ground treatment would be approximately 10m by 10m and extending 15m deep into the Upnor Formation and Thanet Sands Formation.

13.2.11 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 would be constructed from two sheet pile walls. The toe level of the sheet piles would be within the London Clay Formation. Water entering through the cofferdam would be pumped back to the river following any required treatment. It is assumed that the sheet piles in the river would be removed at the end of the construction period. Ground treatment may also be required during the interception and CSO works and to the base of the existing river wall.

Operation

13.2.12 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 outlines the future monitoring and actions in the event of trigger levels being exceeded.

13.3 Assessment methodology

Engagement

13.3.1 Volume 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 Blackfriars Bridge Foreshore site.

[viii] Transmissivity – the ability of rock to transmit water and is a function of its permeability and thickness.

[ix] Grouting – a thin, coarse mortar poured into various narrow cavities, such as rock fissures, to fill them and consolidate the adjoining objects into a solid mass.

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 CSO site during both construction and operation.

13.3.4 The effects on groundwater may however extend beyond a kilometre depending on the hydrogeological setting and the method of construction used. These effects are considered to be of wider regional significance and are assessed in the project-wide assessment (see Vol 3).

Construction

13.3.5 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.

13.3.6 The assessment year applied to the construction assessment is Site Year 2 of construction (2018), when dewatering would first take place outside the diaphragm wall and the volumes of dewatering would be at their greatest. The baseline is not anticipated to change substantially between 2011 and Site Year 2 of construction and so baseline data from 2011 have formed the basis (base case) for the construction assessment.

13.3.7 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.

13.3.8 The developments considered as part of the base case and those included in the cumulative effects assessment are presented in Vol 18 Table 13.3.1 below. The developments relevant to groundwater are those which would contain basements, piling or GSHP's.

Vol 18 Table 13.3.1 Groundwater – construction base case and cumulative assessment developments (2018)

Development	Component or receptor relevant to groundwater	Construction base case	Cumulative effect assessment	Comments (if required)
1 Blackfriars Road (Beethams Tower)	Basement*	✓	✗	Abstraction **28/39/42/0004 not included as already considered in current baseline
1-16 Blackfriars Road	Basement*	✓	✗	N/a

Development	Component or receptor relevant to groundwater	Construction base case	Cumulative effect assessment	Comments (if required)
2 - 4 Tudor Street	None	✓	✗	N/a
20 Blackfriars Road	Basement* GSHP**	✓	✗	N/a
231-241 Blackfriars Road	Basement*	✓	✗	N/a
30 Old Bailey	Basement*	✓	✗	N/a
Bankside 4, Holland Street	Basement*	✓	✗	N/a
Elizabeth House, 39 York Road	Basement*	✓	✗	N/a
Land bounded by Upper Ground and Doon St (adjacent to Cornwall Rd)	Basement*	✓	✗	N/a
London Eye Pier Extension	None	✓	✗	N/a
Ludgate and Sampson House	Basement*	✗	✓	N/a
Puddle Dock Mermaid theatre	Basement* GSHP**	✓	✗	N/a
Tate Modern	Basement* GSHP**	✓	✗	N/a

** Relevant to the upper aquifer*
*** Relevant to the lower aquifer*
Symbols ✓ applies ✗ does not apply

13.3.9 Section 13.5 details the likely significant effects arising from the construction at the Blackfriars Bridge Foreshore site. Other nearby Thames Tideway Tunnel project sites which could give rise to additional effects on groundwater resources are Kirtling Street and Blackfriars Bridge Foreshore. These Thames Tideway Tunnel project sites are therefore included in this assessment.

Operation

13.3.10 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.

13.3.11 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 the 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 have formed the operation base case.

13.3.12 The developments considered as part of the operational base case are included in Vol 18 Table 13.3.2 below. No developments have been identified which would be considered as part of the cumulative effects assessment. The receptors relevant to groundwater are those which would contain basements, piling or GSHPs.

Vol 18 Table 13.3.2 Groundwater – operational base case and cumulative assessment developments (2023)

Development	Component or receptor relevant to groundwater	Operational base case	Cumulative effect assessment	Comments (if required)
1 Blackfriars Road (Beethams Tower)	Basement*	✓	✗	Abstraction **28/39/42/0004 not included as already considered in current baseline
1-16 Blackfriars Road	Basement*	✓	✗	N/a
2 - 4 Tudor Street	None	✓	✗	N/a
20 Blackfriars Road	Basement* GSHP**	✓	✗	N/a
231-241 Blackfriars Road	Basement*	✓	✗	N/a
30 Old Bailey	Basement*	✓	✗	N/a
Bankside 4, Holland Street	Basement*	✓	✗	N/a
Elizabeth House, 39 York Road	Basement*	✓	✗	N/a
Land bounded by Upper Ground and Doon St (adjacent to Cornwall Rd)	Basement*	✓	✗	N/a
London Eye Pier Extension	None	✓	✗	N/a
Ludgate and Sampson House	Basement*	✓	✗	N/a

Development	Component or receptor relevant to groundwater	Operational base case	Cumulative effect assessment	Comments (if required)
Puddle Dock Mermaid theatre	Basement* GSHP**	✓	✗	N/a
Tate Modern	Basement* GSHP**	✓	✗	N/a

** Relevant to the upper aquifer*
*** Relevant to the lower aquifer*
Symbols ✓ applies ✗ does not apply

13.3.13 Section 13.6 details the likely significant effects arising from the operation at the Blackfriars Bridge 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

13.3.14 The construction assumptions relevant to this site are presented in Section 13.2.

13.3.15 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 $90m^2/d$ (Environment Agency and ESI, 2010) [3] and a storativity[x] value of approximately 1×10^{-4} (see Vol 2 Section 13).

13.3.16 The amount of pumping required from outside of the diaphragm wall at the Blackfriars Bridge Foreshore site is assumed to be approximately $440m^3/d$.

13.3.17 The assessment of obstruction effects in Sections 13.5 and 13.6 is based on estimated hydraulic gradient[xi] of 0.004 in the upper aquifer across the site.

13.3.18 The upper aquifer is assumed to be in hydraulic continuity with the overlying layers, Alluvium and Made Ground.

13.3.19 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 west in the area of the Blackfriars Bridge Foreshore site.

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[x] Storativity – the volume of water released for a unit change in water level (in a confined aquifer).
[xi] Hydraulic gradient – the slope of the water table which drives groundwater movement.

13.3.20 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).

13.3.21 The main tunnel shaft construction involving a diaphragm wall would contain an effective seal with the surrounding ground, thereby ensuring no pathway for groundwater contamination to occur.

13.3.22 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.

13.3.23 For the purposes of this assessment, deep refers to greater than 10m below ground level.

Limitations

13.3.24 No site-specific pumping tests have not been undertaken yet as part of the ground investigations. In the absence of site-specific hydrogeological data, published sources of hydrogeological information have been used in this assessment (see Vol 18 Appendix K.2).

13.3.25 Groundwater level data available for this assessment is limited, with monitoring data typically available from one borehole within the upper aquifer and one borehole within the lower aquifer. This means that hydraulic 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 levels might occur.

13.3.26 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 assessments is supported by Vol 18 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 the Lambeth Group (including the Upnor Formation). The base slab would be founded in the Thanet Sands Formation. 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 18 Figure 13.4.1 and Vol 18 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. The Upnor Formation, Thanet Sands and Chalk form the lower aquifer and are classified by the EA as a principal aquifer. The London Clay Formation is expected to act as a confining layer between these two aquifers at the Blackfriars Bridge

Foreshore site. The Harwich Formation is expected to be water-bearing and to contain groundwater under pressure. In addition, the Lambeth Group is expected to contain several confined[xii] groundwater layers, such as in a sand unit at the top of this formation.

13.4.5 The depths and thicknesses of the geological layers have been determined by reference to ground investigation boreholes located both on site and up to 230m off site: SR1058, SR2047, SR2048, SR2049 and SR5011. The locations of these boreholes around the site are shown in Vol 18 Figure13.4.1 (see separate volume of figures). The depths and thicknesses of geological layers encountered are summarised in Vol 18 Table 13.4.1.

Vol 18 Table 13.4.1 Groundwater – anticipated ground conditions/hydrogeology

Formation	Top elevation* (mATD)	Depth (m)	Thickness (m)	Hydrogeology
Alluvium	96.50	0.00	1.50	Hydraulic continuity with upper aquifer**
River Terrace Deposits	95.00	1.50	2.00	Upper aquifer
London Clay				Aquiclude**[xiii]
B	93.00	3.50	3.00	
A3ii	90.00	6.50	7.60	
A3i	82.40	14.10	3.75	
A2	78.65	17.85	11.81	
Harwich Formation	66.84	29.66	0.32	Aquitard***[xiv] / aquifer
Lambeth Group				Aquitards/ aquifers
Sand Unit	66.52	29.98	2.50	
UMB	64.02	32.48	4.50	
LtB	59.52	36.98	0.75	
LSB	58.77	37.73	0.55	
LMB	58.22	38.28	3.67	
UPN (Gv)	54.55	41.95	2.07	Lower aquifer
UPN	52.48	44.02	3.46	
Thanet Sand	49.02	47.48	10.27	
Seaford Chalk	38.75	57.75	Not proven	

** Based on an assumed ground level of 104.60mATD and top elevation of over-water boreholes is approximately 4m below assumed ground level.*

[xii] 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

***It has been assumed that the made ground and alluvium are in hydraulic connectivity for the purposes of this assessment.*
At borehole SR1061A, used for groundwater level monitoring, the top of the Alluvium is at 98.2mATD
UMB–Upper Mottled Beds; LtB–Laminated Beds; LSB-Lower Shelly Beds; LMB-Lower Mottled Beds; UPN (Gv)-Upnor Formation (Gravel); UPN-Upnor Formation.

Groundwater level monitoring

13.4.6 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 records available dating back over 50 years.

13.4.7 Information on groundwater levels for this assessment was collected from two ground investigation boreholes located within 600m of the Blackfriars Bridge Foreshore site (PR1060 and SR1061A). The origin of these boreholes is detailed in Vol 18 Appendix K.3, Vol 18 Table K.4. These boreholes have response zones[xv] in the Alluvium and Seaford Chalk and are monitoring groundwater levels in the upper and lower aquifers. The locations are shown in Vol 18 Figure13.4.3 (see separate volume of figures). Vol 18 Table 13.4.2 below summarises the minimum, average and maximum water levels at the three ground investigation boreholes.

Vol 18 Table 13.4.2 Groundwater – water level summary

Borehole	Formation	Maximum month year (mATD)	Minimum month year (mATD)	Average over the period of record (mATD)
SR1061A	Alluvium	98.66 (Feb 2010)	98.09 (Nov 2011)	98.49
PR1060	Seaford Chalk	60.86 (June 2011)	58.51 (Sept. 2010)	59.76
TQ28/119*	Chalk	65.12 (May 2000)	12.41 (Mar. 1967)	35.68

** Water level records exist from 1845 but are sporadic; minimum, maximum and average values are calculated based on readings from 1950 onwards.(The location of borehole TQ28/11 and its respective hydrograph is shown in Vol 18 Figure 13.4.4, see separate volume of figures.)*

13.4.8 The recorded water levels in the Alluvium at SR1061A range from 98.01mATD to 98.79mATD. These water levels fluctuate above and below the top of the formation of the Alluvium in this borehole of 98. 2mATD, suggesting that this formation is influenced by tidal fluctuations.

13.4.9 The recorded water levels (piezometric head) in the Chalk at PR1060 range from 57.95mATD to 61.55mATD. These water levels consistently remained above the top of the formation at 38.75mATD, indicating that this

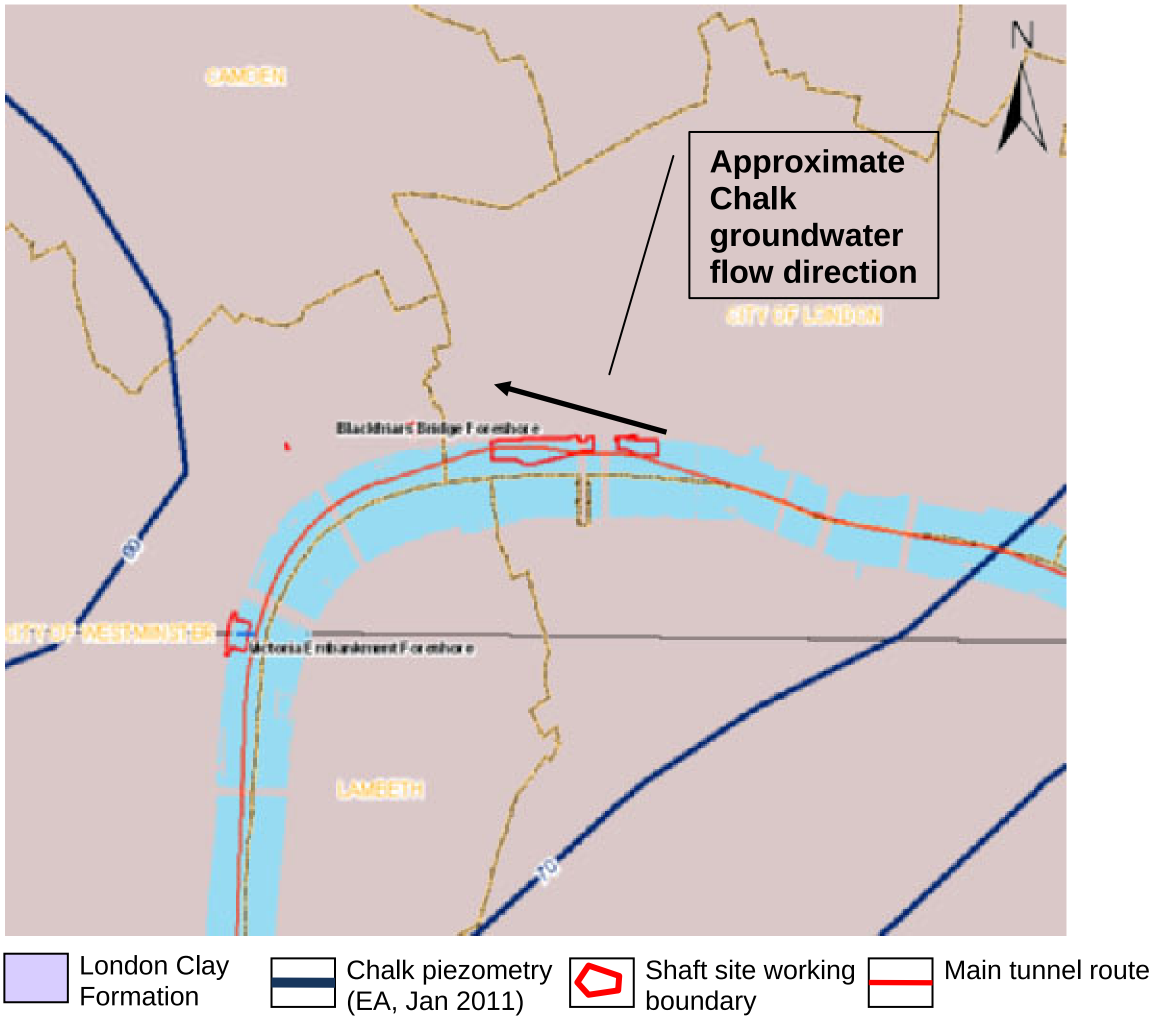
[xv] Response zone - the section of a borehole that is open to the host strata (EA, 2006).

formation is fully saturated and confined by the overlying London Clay Formation and Lambeth Group.

13.4.10 A plot of groundwater levels within the Alluvium and Chalk in the vicinity of the site is shown in Vol 18 Figure13.4.3 (see separate volume of figures). There is one borehole in the upper aquifer near the site (SR1061A) and therefore it is difficult to determine the direction of groundwater flow. However it is likely that the direction of groundwater movement is from north to south, with topography and towards the River Thames, in these shallow deposits.

13.4.11 The EA produces an annual regional groundwater level contour map (piezometry) of the Chalk, showing a snap-shot of groundwater flows in time4. The January 2011 map indicates that the regional direction of groundwater flow (perpendicular to groundwater contours) at this point in time was to the west northwest in the Chalk around Blackfriars Bridge (see Vol 18 Plate 13.4.1).

Vol 18 Plate 13.4.1 Groundwater – contour map for the Chalk



**Extract from Vol 18 Figure 13.4.2 (see separate volume of figures).*

13.4.12 Further detail on water level monitoring is provided in Vol 18 Appendix K.3.

Licensed abstractions

13.4.13 There are no licensed groundwater abstractions from the River Terrace Deposits or upper aquifer located within 1km of the Blackfriars Bridge Foreshore site; however there are four licensed groundwater abstractions and one unlicensed groundwater abstraction from the Chalk (lower aquifer) located within 1km of the site. The location of licensed and unlicensed abstraction licences is shown in Vol 18 Figure 13.4.5 (see separate volume of figures).

13.4.14 These sources lie to the south, southwest, northeast and northwest of the Blackfriars Bridge Foreshore site and are considered to be located up or across hydraulic gradient from the Blackfriars Bridge Foreshore site.

13.4.15 The use of these licences is for industrial, commercial and public services, including for drinking, process water and heating and cooling purposes and are detailed further in Vol 18 Appendix K.4.

Groundwater source protection zone

13.4.16 The EA defines Source Protection Zone (SPZ) around all major public water supply abstractions sources and large licensed private abstractions in order to safeguard groundwater resources from potentially polluting activities. The nearest modelled SPZ for a Chalk source is at approximately 1.7km to the north. This is not in direction of the expected groundwater flow direction beneath the site, which is towards the west northwest.

Environmental designations

13.4.17 There are no designations relevant to groundwater within 1km of the site.

Groundwater quality and land quality

13.4.18 The groundwater quality data presented in Vol 18 Appendix K.7, Vol 18 Table K.8 has been sourced from the ground investigation and monitoring works undertaken as part of the Thames Tideway Tunnel project and includes data from monitoring boreholes located up to 670m from the Blackfriars Bridge Foreshore site (SR1058, SR1061A and SR1062) (for locations see Vol 18 Figure13.4.1 within a separate volume of figures) and within the Made Ground, River Terrace Deposits and Chalk. The origin of these boreholes and groundwater quality data is detailed in Vol 18 Appendix K.7, Vol 18 Table K.8.

13.4.19 The data shows only one exceedance of the relevant standard within the River Terrace Deposits at SR1062 (located 670m from the site) with respect to sulphate. Further details are provided in Vol 18 Appendix K.7.

13.4.20 The EA monitors groundwater quality at number of points across London. The nearest EA monitoring is at Dolphin Square, which lies approximately 3km away to the southwest of the Blackfriars Bridge Foreshore site. The data here shows exceedances of the UK drinking water standard within the Chalk with respect to ammonia, pesticides, herbicides, heavy metals, sulphate, potassium, PAH’s and benzene.

13.4.21 The land quality data from the ground investigation boreholes used in the groundwater quality assessment show exceedances of the human health screening values (EA, 2009)[6] (soil guideline values designed to be protective of human health) within the River Terrace Deposits with respect to sulphate. Further detail is provided in the land quality assessment (see Vol 18 Appendix F).

Groundwater flood risk

13.4.22 There are no reported incidences of groundwater flooding in the vicinity of the site, based on information from the *City of London Strategic Flood Risk Assessment* (*SFRA*) (Parkman, 2007)[7].

Groundwater receptors

13.4.23 Groundwater receptors which could be affected during construction or operation are summarised in Vol 18 Table 13.4.3 below. Both the upper and lower aquifers have been assessed as receptors as both would be penetrated by the CSO drop shaft at the Blackfriars Bridge Foreshore site. There are four licensed abstraction sources and one unlicensed source from the Chalk within 1km radius of the site and which have also been assessed for the construction phase.

Vol 18 Table 13.4.3 Groundwater – receptors

Receptor	Construction	Operation	Comment	Details
Groundwater body – upper aquifer	✓	✓	Penetrated by CSO drop shaft, connections, overflow weir chambers and culverts	
Groundwater body – lower aquifer	✓	✓	CSO drop shaft into Upnor Beds and base slab into Thanet Sand	
Licensed abstractions – upper aqufer	✗*	✗*	None known	
Licensed abstractions – lower aquifer	✓*	✗*	Four Chalk abstractions	28/39/39/0229 28/39/42/0004 28/39/39/0008 28/39/42/0069**
Unlicensed abstractions	✓*	✗*	One known abstraction	CL1***
Planned developments and abstractions	✓	✗*	One planned GSHP in the upper aquifer, two planned Ground Source	Tate modern (UA), Puddle Dock and 20 Blackfriars Road

Receptor	Construction	Operation	Comment	Details
			Heat Pumps (GSHP's) in the lower aquifer	(both LA)

**Abstractions (licensed and unlicensed) would only be affected by construction phase, due to dewatering.*
*** Abstraction licence numbers*
**** Unlicensed receptor reference number – see Vol 18 Figure 13.4.5 in separate volume of figures.*
Symbols ✓ applies ✗ does not apply

Receptor sensitivity

13.4.24 The upper aquifer is classified by the EA as a secondary A aquifer and is allocated a medium value in terms of quantity and quality in this assessment.

13.4.25 The lower aquifer is a principal aquifer as classified by the EA, and hence is categorised as being of high value with regard to quantity and quality.

13.4.26 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.

13.4.27 A summary of receptor sensitivities used in the assessments that follow is included in Vol 18 Table 13.4.4.

Vol 18 Table 13.4.4 Groundwater – receptor value

Receptor	Value/sensitivity
Groundwater quality	
Upper aquifer	medium value, secondary aquifer
Lower aquifer	high value, principal aquifer
Groundwater quantity (resources)	
Upper aquifer	medium value, secondary aquifer
Lower aquifer	high value, principal aquifer
Licensed Chalk abstraction 28/39/39/0229	high value; drinking water purposes
Licensed Chalk abstraction 28/39/42/0004	medium value; industrial source and process water purposes
Licensed Chalk abstraction 28/39/39/0008	high value; large GSHP scheme from the Chalk

Receptor	Value/sensitivity
Groundwater quality	
Licensed Chalk abstraction 28/39/42/0069	medium value; industrial, commercial and public services
Unlicensed Chalk abstraction (CL1)	medium value, purpose unspecified

Construction base case

13.4.28 The construction base case in Site Year 2 is as per the current baseline and also includes any developments that are likely to be complete and partially or fully operational during the construction phase at the Blackfriars Bridge Foreshore site (starting in 2017), and would have the potential to lead to a change to groundwater in the upper and lower aquifer.

13.4.29 The basements and piling associated with other developments identified in Vol 18 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.

13.4.30 The base case in Site Year 2 of construction at the Thames Tideway Tunnel project site would include the planned abstractions for GSHP in the upper aquifer at Tate Modern, and the lower aquifer, at Puddle Dock Mermaid Theatre and 20 Blackfriars Road, as identified in Vol 18 Table 13.3.1 as these are likely to be active at the time of construction.

Operational base case

13.4.31 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, connection culverts and interception chambers. The impact of this project-wide dewatering is discussed in detail in Vol 3 Section 13. Impacts have been quantified by modelling (see Vol 3 Appendix K.2) and the effects, where they are of relevance to the Blackfriars Bridge Foreshore site, are included in this assessment.

13.5.2 In order to construct the CSO drop shaft, dewatering of the Upnor Formation (Lambeth Group) and the Thanet Sands would be required. The Upnor Formation and Thanet Sands are known to be in hydraulic connection with each other and with the underlying Chalk. Dewatering of the Upnor Formation and the Thanet Sands would be achieved by abstracting water from the Chalk (dewatering) as described in Section 13.2. An estimate of the average amount of dewatering which would be needed at the Blackfriars Bridge Foreshore site is approximately 1085m^3/d.

13.5.3 The effects on licensees in the vicinity of Blackfriars Bridge Foreshore site have been set out in the modelling report (see Vol 3 Appendix K.2). For each licensee the impact of drawdown has been assessed by comparing it to the maximum available drawdown[xvi] at the licensee's borehole(s):

a. In the case of licence number 28/39/39/0229, this borehole has an estimated pumped water level of only 4m above the estimated pump depth. Modelling has predicted a drawdown of approximately 5.5m, which would exceed the maximum permissible headroom of 4m for an extended period of potentially up to 28 months. Therefore, there is a risk that this source may be significantly affected by the dewatering at Blackfriars Bridge Foreshore site. While enquiries with the licence holder in January 2012 indicate that the source has not been used due to a water quality issue, the effect on the integrity of this attribute means that the magnitude of impact would be medium.

b. In the case of licence number 28/39/42/0004, this borehole has an estimated pumped water level of 18m above the estimated pump depth. Modelling has predicted a drawdown of approximately 5.7m, which is less than the maximum permissible headroom. The magnitude of impact would be negligible.

c. In the case of licence number 28/39/39/0008, this borehole has an estimated pumped water level of 19m above the estimated pump depth. Modelling has predicted a drawdown of approximately 4.9m, which remains below the maximum permissible headroom. The magnitude of impact would be negligible.

d. In the case of licence number 28/39/42/0069, this borehole has an estimated pumped water level of 20m above the estimated pump depth. Modelling has predicted a drawdown of approximately 5m, which remains below the maximum permissible headroom. The magnitude of impact would be negligible.

e. Although no details are available for the private unlicensed sources CL1 (C Hoare & Co) which lies 0.3 km to north and abstracts small volumes from the Chalk for purposes unspecified, it is considered unlikely that it would be significantly affected and the impact magnitude is assessed conservatively as low.

Groundwater quality

13.5.4 The baseline groundwater and land quality data shows no exceedances of the relevant standards in close proximity to the Blackfriars Bridge

[xvi] 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.

Foreshore site and only one exceedance with respect to sulphate in both groundwater and soil samples collected within the River Terrace Deposits at SR1062 (located at 670m from the site). The main tunnel shaft construction involving a diaphragm wall would contain an effective seal with the surrounding ground, thereby ensuring no pathway for groundwater contamination at the surface or shallow geological units to occur. Therefore the magnitude of the impact, as a result of the creation of pathways for pollution, has been assessed to be negligible on the upper aquifer.

13.5.5 There is no baseline groundwater quality data available for the Chalk (lower aquifer) in close proximity to the site. The change in hydraulic gradients and groundwater flow velocities in the eastern areas are anticipated to be small (from 38 to 53 m/year). The dewatering at the Blackfriars Bridge site would be substantial at approximately 1,085m^3/day, however given the lack of data, the threat of mobilising contamination is considered to be negligible.

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 would draw water levels down at the Blackfriars Bridge Foreshore site by an estimated 8m and this level of drawdown is not anticipated to result in any substantial changes in groundwater quality. Therefore the magnitude of the impact from dropping water levels has been assessed to be negligible on the lower aquifer.

13.5.7 The grouting, if necessary would be in the base of the Lambeth Group in the Upnor Formation and Thanet Sands Formation. 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. Grout setting generally occurs on a timescale of a few minutes and therefore in most circumstances the impact is likely to be localised. In addition, dewatering from the Chalk and under-draining of the Upnor Formation and Thanet Sands would minimise the migration of grout by drawing groundwater towards the CSO drop shaft. The magnitude of the impact on the lower aquifer is assessed to be negligible.

13.5.8 Grouting may also be required during the interception and CSO works and to the base of the existing river wall. Any effects are expected to be localised. The magnitude of the impact on the upper aquifer is assessed to be negligible.

Physical obstruction

13.5.9 The presence of the diaphragm walls used to build the CSO drop shaft may disrupt groundwater flow and alter groundwater levels in both the upper and lower aquifers.

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.2. It is estimated that the groundwater level would rise during the construction phase at Blackfriars Bridge Foreshore site by approximately 0.3m, based on an estimated hydraulic gradient of 0.004.

13.5.11 Groundwater levels in the Alluvium can reach 98. 5mATD; this is approximately 6.1m below the existing ground surface at Blackfriars Bridge Foreshore site. Given the small predicted rise in water levels (0.3m) on the north side of the site, the magnitude of impact would be negligible.

13.5.12 The CSO drop shaft would extend down approximately 8m (from the top of the Upnor Formation) into the lower aquifer, which is over a 100m thick and would not obstruct flows. There are no abstractions lying downstream along the hydraulic gradient to the west of the Blackfriars Bridge Foreshore site and so the impact of physical obstruction has been assessed as negligible.

Construction effects

13.5.13 By combining the impacts identified above with the receptor value in paras. 13.4.24 and 13.4.25, the significance of the effects can be derived using the generic significance matrix (Vol 2 Section 3). The results are described in the following paras.

Dewatering of aquifers

13.5.14 Overall, the effects from dewatering of the lower aquifer are expected to be between major adverse and negligible effects depending on the licence use as follows:

a. Licence number 28/39/39/0229 is classified as a high value receptor in terms of groundwater resources. A medium impact on this high value receptor would result in a temporary **major adverse** effect. The duration of this impact is predicted to be approximately 28 months.

b. Licence number 28/39/42/0004 is licensed for used for industrial purposes only and is classified as being of medium value. A negligible impact on a medium value receptor, gives an overall **negligible** effect.

c. Licence number 28/39/39/0008 is a large source used for GSHP and is classified as being of high value. A negligible impact on a high value receptor gives an overall **minor adverse** effect.

d. Licence number 28/39/42/0069 is licensed for use for industrial purposes only and is classified as being of medium value. A negligible impact on a medium value receptor gives an overall **negligible** effect.

e. The unlicensed source CL1 is used for purposes unspecified and is classified as being of medium value. A low impact on a medium value receptor gives an overall **minor adverse** effect.

13.5.15 The main impacts on current groundwater users are expected to be manageable in terms of being able to continue their use during the scheme at three locations, while at the fourth location the drawdown in the lower aquifer is anticipated to compromise the ability of the licence holder to use their source.

Groundwater quality

13.5.16 A negligible impact on groundwater quality in the upper aquifer has been identified as a result of no dewatering, the use of sheet piles and secant piles and no groundwater contamination being identified in close proximity to the site. A negligible impact on groundwater quality of a medium value receptor, the upper aquifer, would result in a **negligible** effect.

13.5.17 No groundwater contamination has been identified in close proximity to the site. Any change in hydraulic gradients and groundwater flow velocities would be small. As a result an impact magnitude of negligible has been assigned for groundwater quality in the lower aquifer. A negligible impact on groundwater quality of a high value receptor, the lower aquifer, would result in a **minor adverse** effect.

13.5.18 A negligible impact on groundwater quality in the lower aquifer has been identified as a result of a small drawdown of groundwater levels below the top of the Thanet Sands. A negligible impact on a high value receptor, the lower aquifer, 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 at the Lambeth Group for the construction of the base slab. A negligible impact on a high value receptor would result in a **minor adverse** effect.

13.5.20 A negligible impact on groundwater quality in the upper aquifer has been identified as a result of grouting in the River Terrace Deposits for the interception and CSO works. A negligible impact on a medium value receptor would result in a **negligible** effect.

Physical obstruction

13.5.21 A negligible impact on groundwater levels in the upper aquifer has been identified as a result of the presence of the sheet pile or secant pile walls and the CSO drop shaft construction activities. A negligible impact on groundwater quantity of a medium value receptor, the upper aquifer, would result in a **negligible** effect.

13.5.22 A negligible magnitude impact on groundwater quantity of a high value, the lower aquifer, 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 method for assessing the impact of the main tunnel and drop shafts 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 Blackfriars Bridge Foreshore site would be less than 0.1m, based on an assumed hydraulic gradient of 0.004.

13.6.3 Groundwater levels in the Alluvium can reach 98. 5mATD; this is approximately 6.1m below the existing ground surface at Blackfriars Bridge Foreshore site. Given the small predicted rise in water levels (less than 0.1m) on the north side of the site, the magnitude of impact on the upper aquifer would be negligible.

13.6.4 The physical obstruction of the lower aquifer would be insignificant given that only the base slab of the constructed CSO drop shaft would extend down into the top of the lower aquifer by only about 8m. This is minor fraction of the total thickness of the lower aquifer, which is estimated to be at least 100m thick at the site. Therefore the magnitude of impact on the lower aquifer would be negligible.

Seepage into CSO drop shaft

13.6.5 An estimate of the seepage volumes into the CSO drop shaft at Blackfriars Bridge Foreshore site is included in Vol 2 Appendix K.3. The estimated loss of water resources from the upper aquifer from seepage is $203m^3$/annum or $0.56m^3$/d (Vol 2 Appendix K.3, Vol 2 Table K.4). The magnitude of impact has been assessed as negligible for the upper aquifer.

13.6.6 The estimated loss of water resources from the lower aquifer is 69m3/year which is considered to be a negligible impact

Seepage from CSO drop shaft

13.6.7 An estimate of the seepage volumes from the CSO drop shaft at Blackfriars Bridge 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 (Vol 3 Section 13). The estimated volume of seepage from the CSO drop shaft into the upper aquifer is $2m^3$/annum (Vol 2 Appendix K.3, Vol 2 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 CSO drop shaft into the lower aquifer is $6m^3$/annum (Vol 2 Appendix K.3, Vol 2 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 importance (see paras. 13.4.24 and 13.4.25) with the impacts identified above, the significance of the effects can be derived using the generic significance matrix (Vol 2 Section 3). The results are described in the following sections.

Physical obstruction

13.6.11 A negligible impact on groundwater levels in the upper aquifer has been identified as a result of the presence of the sheet pile walls and the CSO drop shaft construction activities. A negligible impact on groundwater quantity of a medium value receptor (the upper aquifer) and would lead to a **negligible** effect.

13.6.12 A negligible impact on groundwater levels and storage in the lower aquifer has been identified as a result of the shaft extending only a small distance into the lower aquifer. A negligible impact on a high value receptor (lower aquifer) would lead to a **minor adverse** effect.

Seepage from CSO drop shaft

13.6.13 Seepage from the drop shaft has been determined as a negligible impact on groundwater quality, which on a medium value receptor (the upper aquifer) would lead to a **negligible** effect. The same impact on a high value receptor (the lower aquifer) would lead to a **minor adverse** effect.

Seepage into CSO drop shaft

13.6.14 Seepage into the drop shaft has been determined as a negligible impact on groundwater resources, which on a medium value receptor (the upper aquifer) would lead to a **negligible** effect. The same impact on a high value receptor (the lower aquifer) would lead to a **minor adverse** effect

13.7 Cumulative effects assessment

Construction effects

13.7.1 One development identified in Vol 18 Table 13.3.1 could potentially give rise to cumulative effects to groundwater in the upper aquifer through the inclusion of a basement. Although there may be a local impact on groundwater levels in the upper aquifer due to the vicinity of the developments, any effects are not expected to be significant because the development is greater than 50m away from the site. Beyond 50m the effects from our structure on the upper aquifer are unlikely to be detectable. Any substantive changes to the baseline conditions prior to construction would be detected by ongoing monitoring.

13.7.2 This development would not impact on the lower aquifer, and therefore there would be no cumulative effects in the lower aquifer. The effects on groundwater during construction would remain as described in Section 13.5.

Operational effects

13.7.3 None of the developments identified within 1km of the Blackfriars Bridge Foreshore site and described in Vol 18 Table 13.3.2 are relevant to the cumulative operational effects assessment and therefore an assessment is not required. The effects on groundwater during operation would remain as described in Section 13.6.

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 and the potential impacts on licensed abstractors during the construction phase.

Mitigation of construction effects

13.8.3 The quantification of impacts has shown the large dewatering at Blackfriars Bridge Foreshore would cause a **major adverse** effect on one groundwater abstraction licence 28/39/39/0229 (Global Grange Limited). This effect is in part due to the small estimated headroom between pump depth and pumped water level. At this location, the maximum available drawdown has been estimated to be 4m and estimated drawdown is 5.5m for 28 months. This amount of excess drawdown over the maximum permissible amount of drawdown is such that a mitigation scheme for this abstraction licence would be required to ensure that the licensed source can continue to be used for the duration of the dewatering at Blackfriars Bridge Foreshore site.

13.8.4 The mitigation for abstraction licence 28/39/39/0229 (Global Grange Limited) would comprise lowering the pump in the borehole should the groundwater levels fall below the existing pump depth, deepening borehole or provision of alternative supply. These options would be discussed with the licence holder and mitigation measures agreed.

13.8.5 The various drawdowns stated above are those at the point when the CSO drop shaft is being excavated to its maximum depth. Dewatering from within the shaft would mitigate the effects on the Chalk abstractions and the lower aquifer in general. It is also proposed to only lower water levels by an amount that keeps the required excavation depth dry at any point ie dewatering to maximum CSO drop shaft depth would be done for the shortest practical period.

13.8.6 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 which would be required to mitigate the dewatering effects on abstraction licence 28/39/39/0229 (Global Grange Limited) would have the effect of reducing the significance of residual construction effects to a minor adverse effect. It should be noted that given the structure of the generic significance of effects matrix, the high value of the lower aquifer means that effects are always at least minor adverse.

13.9.2 All residual effects are presented in Section 13.10.

Operational effects

13.9.3 As no mitigation measures are required, 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 18 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	28/39/39/0229 - Major adverse	Lowering of pump, deepening the borehole or provision of alternative supply Use of internal dewatering	Minor adverse
Lower aquifer (licensed Chalk abstractions)	Lowering of groundwater levels in the Chalk resulting from dewatering	28/39/42/0004 - Negligible	None	Negligible
Lower aquifer (licensed Chalk abstractions)	Lowering of groundwater levels in the Chalk resulting from dewatering	28/39/39/0008 - Minor adverse	None	Minor adverse
Lower aquifer (licensed Chalk abstractions)	Lowering of groundwater levels in the Chalk resulting from dewatering	28/39/39/0069 - Negligible	None	Negligible
Lower aquifer (unlicensed Chalk abstraction)	Lowering of groundwater levels in the Chalk resulting from dewatering	CL1 - Minor adverse	None	Minor adverse
Upper aquifer	Deterioration in groundwater quality caused by creation of a pathway	Negligible	None	Negligible
Lower aquifer	Deterioration in groundwater quality caused by creation of a pathway	Minor adverse	None	Minor adverse
Lower aquifer	Deterioration in water quality by drawing down water levels below top of Thanet	Minor adverse	None	Minor adverse

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
	Sands			
Lower aquifer	Deterioration in water quality in the Chalk from grouting	Minor adverse	None	Minor adverse
Upper aquifer	Deterioration in water quality in the River Terrace Deposits from grouting	Negligible	None	Negligible
Upper aquifer	Change in groundwater levels as a result of physical obstruction in upper aquifer	Negligible	None	Negligible
Lower aquifer	Change in groundwater levels as a result of physical obstruction in lower aquifer	Minor adverse	None	Minor adverse

Vol 18 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 CSO drop shaft affecting groundwater resources	Negligible	None	Negligible
Lower aquifer	Seepage into shaft affecting groundwater resources	Minor adverse	None	Minor adverse
Upper aquifer	Deterioration in water quality in the upper aquifer from seepage out of CSO drop shaft	Negligible	None	Negligible
Lower aquifer	Deterioration in water quality in the lower aquifer from seepage out of CSO 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).

[3] Environment Agency and ESI. *London Basin Aquifer Conceptual Model*. *ESI Report Reference 60121R1* (June 2010).

[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).

[6] Environment Agency. *Soil Guideline Value Reports* (2009). Available at: http://www.environment-agency.gov.uk/research/planning/64015.aspx.

[7] Mouchel Parkman. *City of London Strategic Flood Risk Assessment* (August 2007).

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.18**

Volume 18 Blackfriars Bridge Foreshore site assessment

Section 14: Water resources - surface water

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 18: Blackfriars Bridge 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 Blackfriars Bridge 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 Vol 2 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 of existing surface water resources baseline conditions

b. determining base case conditions against which the proposed development has been assessed

c. assessment of significant effects of the proposed development during construction and operation

d. identification of mitigation measures and the residual effects both during construction and operation.

14.1.4 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 of this volume. 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.

14.1.5 This assessment covers the effects of the proposed development at the Blackfriars Bridge Foreshore site and in particular in relation to the interception of the Fleet Main combined sewer overflow (CSO). It is however important to recognise that whilst the reduction in spills from the Fleet Main CSO would be important to water quality in the immediate area of the CSO outfall, 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 Thames Tideway Tunnel project are assessed separately and presented in Volume 3 Project-wide effects assessment Section 14.

14.1.6 Plans of the proposed development as well as figures included in the assessment for this site are contained in a separate volume (Volume 18 Blackfriars Bridge 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 Blackfriars Bridge 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. The working area consists of a temporary cofferdam and, at the western section of the site, a steel working deck supported on piles (shown on the Construction plans, see separate volume of figures – Section 1). The working deck is to be used for handling and treatment of excavated material during construction phase two and for office and welfare facilities during construction phase three.

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 excavations from the CSO drop shaft and other structures. The river channel would be dredged to provide sufficient depth of water at all tides to allow the barges to moor up adjacent to the site while loading and unloading occurs.

14.2.4 A CSO drop shaft would be constructed at the site. Based on the geology at the site, the construction of the drop shaft and associated infrastructure would require dewatering and or ground treatment. 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 The Blackfriars Millennium Pier is currently located to the west of Blackfriars Bridge, within the Blackfriars Bridge Foreshore site. In order to facilitate the construction works at the site, the pier would be relocated to the east of Blackfriars Bridge, within the secondary site known as Blackfriars Pier. This relocation would be permanent and the pier would remain to the east of the bridge after on-site works have finished.

14.2.6 The President is currently moored within the site beyond the Blackfriars Millennium Pier further west and would be temporarily relocated to Chrysanthemum Pier to the west of its current location. It is assumed that the President would be returned to its current location (to a rebuilt mooring) once construction works are complete. The mooring at Chrysanthemum Pier would require modification to accommodate the President.

14.2.7 The construction of in-river structures and in particular the temporary cofferdam would affect the river regime with the potential that localised increases in flow velocity could 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 the *Scour and Accretion Monitoring and Mitigation Plan for Temporary Works in the Foreshore* (Vol 3 Appendix L.4).

Code of Construction Practice

14.2.8 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) includes a number of measures to minimise the potential for impacts to surface waters, including impacts such as discharge of pollutants via surface water drains, and these are summarised below.

14.2.9 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.

14.2.10 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 the surface water drains. Foul drainage from the site welfare facilities would be connected to the mains foul or combined sewer.

14.2.11 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*).

14.2.12 There are no site specific measures incorporated in the *CoCP* Part B (Section 8) relevant to the surface water assessment.

Operation

14.2.13 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 Blackfriars Bridge Foreshore site from

[i] 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 Fleet Main CSO. There would therefore be a reduction in the frequency, duration and volume of spills from this CSO.

14.2.14 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 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 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 Volume 2 Environmental assessment methodology. A WFD assessment for the project as a whole is presented in Vol 3 Project-wide.

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 Site-specific comments relevant to the surface water assessment at the Blackfriars Bridge Foreshore site are provided in Vol 18 Table 14.3.1.

Vol 18 Table 14.3.1 Surface water – stakeholder engagement

Consultee	Comment	Response
City of London Corporation (February 2012)	The River Thames as it runs through Blackfriars is constrained by bridge abutments, flood defences and river walls; however, at low tide areas of unobstructed foreshore are visible. This proposal imposes new structures in the river channel further denaturalising the channel	Likely significant effects from the in-river structures have been considered within Section 14.6. Likely significant effects are also considered in Section 5 of this volume.

Consultee	Comment	Response
	and causing loss of the intertidal foreshore; therefore it is contrary to policy 7.28.	

Baseline

14.3.4 The baseline methodology follows the methodology described in Vol 2. 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. There are no site-specific variations for undertaking the construction assessment of this site.

14.3.6 The assessment year for construction 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. 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 18 Appendix N). The developments in Vol 18 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 of these developments are remote from the tidal Thames. The base case would therefore not change from that outlined above.

14.3.9 No developments have been identified that would be under construction during Site Year 1, therefore a cumulative effects assessment has not been undertaken (Section 14.7).

14.3.10 The assessment area for the assessment of effects of construction activities at Blackfriars Bridge Foreshore site would be limited to two sections of the river, namely the Thames Upper and Middle waterbodies listed below in Vol 18 Table 14.4.1.

14.3.11 Section 14.5 details the likely significant effects arising from the construction at the Blackfriars Bridge 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. 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 18 Appendix N). The developments in Vol 18 Appendix N would not result in additional surface water receptors and are considered unlikely to result in changes in water quality as the majority of these developments are remote from the tidal Thames. The base case would therefore not change from that outlined above.

14.3.15 No developments have been identified that would be under construction during Year 1 of operation, therefore a cumulative effects assessment has not been undertaken (see Section 14.7).

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 Blackfriars Bridge Foreshore site.

Assumptions and limitations

14.3.18 The assumptions and limitations associated with this assessment are presented in Vol 2. Based on the geology at the site, it is assumed that the base of the drop shaft would require dewatering and or ground treatment. 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, is included in Vol 18 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, and hydromorphological elements. Reference should be made to the United Kingdom Technical Advisory Group (UKTAG)[5] guidance, as given in the RBMP (EA, 2009)[6].

Vol 18 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 Estuaries 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, although their current and predicted status in 2015 (target date from RBMP [EA, 2009][7]) is moderate potential, a status objective of good by 2027 has been set. In addition, the tidal Thames is a valuable 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 tidal Thames estuary, or more than 40,000t (or 20,000m^3 assuming an in-situ density of 2t per m^3) 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 Blackfriars Bridge Foreshore site.

14.4.7 The Blackfriars Bridge Foreshore site is close to the EA's spot sample site at London Bridge, as shown on Vol 18 Figure 14.4.1 (see separate volume of figures). Summary data from this monitoring point, which gives 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) for spot sample results collected between 2005 and 2009 is presented below in Vol 18 Table 14.4.2.

Vol 18 Table 14.4.2 Surface water – London Bridge spot samples

EA spot sample site	DO* (mg/l) (10%)	Ammonium (mg/l) (90%)
Thames at London Bridge	4.81	10.92

14.4.8 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.

14.4.9 The discharge from the Fleet Main CSO 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 effect at the Blackfriars Bridge Foreshore site and a more widespread effect along the tidal Thames of rapidly dropping DO levels. Vol 3 details half-tide plots displaying the changes in DO levels along the tidal Thames.

14.4.10 Historical mapping has identified no contaminative activities on site and, while a 250m search radius[ii] has identified pockets of historical industrial activities in the vicinity of the site, none of the sources nearby are considered to have considerably impacted upon the Blackfriars Bridge Foreshore site.

14.4.11 Foreshore sediment sampling carried out at the Blackfriars Bridge Foreshore site has shown contamination of the near surface sediments with low levels of certain metals including arsenic, lead and copper as well as various polycyclic aromatic hydrocarbons (PAHs) above approved sediment guidelines[iii] [9]. 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 Fleet Main CSO has been characterised using the catchment model of the sewer system (See Vol 3 for further details of catchment modelling), and the annual average duration, frequency and volume of spill has been defined as follows:

a. the CSO spills on average 21 times in the Typical Year[iv]

b. the CSO spills for a total duration of 75 hours in the Typical Year

c. the spill volume from the CSO is approximately 521,000m^3 in the Typical Year, representing 1.3% of the total volume discharged to the tidal Thames in the Typical Year from all CSOs.

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ii 250m buffer has been included within the assessment area in order to take account of any off-site sources / receptors, as discussed in the Volume 2 Section 7 Land quality methodology.

iii In order to assess potential risk to surface water resources, reference was made to PLA approved sediment quality guidelines, namely the Canadian Sediment Quality Guidelines for the Protection of Aquatic Life. The guidelines provide contaminant concentration limits in the form of Threshold Effect Level (TEL) and Probable Effect Level (PEL).

iv 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

14.4.13 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 from the Fleet Main CSO has been defined as follows:

a. the CSO discharges 31,000kg of BOD in the Typical Year

b. the CSO discharges 900kg of ammonia in the Typical Year

c. the CSO discharges 6,100kg of TKN in the Typical Year.

14.4.14 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, C, Surman-Lee, S, Sellwood, J and Lee, JV, 2007)[10]. The study concluded that risk of infection can remain for two to four days following a spill as the water containing the sewage moves back and forward with the tide[v]. 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.

14.4.15 Assuming the average 21 spills per annum from the Fleet Main CSO occur on separate days, there could be up to a maximum of 84 days per year where recreational users are at risk of exposure to pathogens in the vicinity of the overflow as a result of the Fleet Main CSO spills alone (Lane, C, Surman-Lee, S, Sellwood, J and Lee, JV, 2007)[11].

14.4.16 The operation of the Fleet Main CSO 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 Fleet Main CSO and assuming litter tonnages are proportional to discharge volumes, this would indicate that approximately 131t of sewage derived litter is discharged from the Fleet Main CSO in the Typical Year. An assessment of amenity effects of the sewage litter is given in Vol 3 Section 10.

Construction base case

14.4.17 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 and sewage works upgrades in place (further details are provided below under operational base case).

14.4.18 The base case in Site Year 1 of construction taking into account the schemes described in Vol 18 Appendix N would not change since no new sensitive receptors would be introduced.

[v] The EA has provided advice on CSO excursion areas[v], 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.

Operational base case

14.4.19 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.

14.4.20 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.

14.4.21 Catchment modelling results of the base case have demonstrated that by Year 1 of operation (assessed using 2021 modelled assumptions), the frequency, duration and volume of spills from the Fleet Main CSO would have increased (as a result of increased population) beyond the current baseline as follows:

a. the CSO would spill 23 times in the Typical Year (2 more than the current baseline)

b. the CSO would spill for 83 hours in the Typical Year (eight hours more than the current baseline)

c. the spill volume from the CSO would be approximately 571,000m^3 in the Typical Year (50,000m^3 more than the current baseline).

14.4.22 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:

a. the CSO would discharge 40,000kg of BOD in the Typical Year (9,000kg more than the current baseline)

b. the CSO would discharge 1,300kg of ammonia in the Typical Year (400kg more than the current baseline)

c. the CSO would discharge 5,200kg of TKN in the Typical Year (1,900kgmore than the current baseline).

14.4.23 Following on from the interpretation of the current baseline, as per para. 14.4.15, the number of risk days for river users being exposed to pathogens during the operational base case year (taking into account 2021 modelled assumptions) would be a maximum of 92 days in the Typical Year as a result of spills from the Fleet CSO alone.

14.4.24 Similarly, the tonnage of sewage derived litter discharged from the Fleet Main CSO can be expected to increase by approximately 9%, from approximately 131t to approximately 144t 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 assessment of effects is required (eg, where the impact pathway has been removed). The second part of the section 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 Blackfriars Bridge 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 could lead to changes in scour and deposition of sediments.

Release of sediments from piling, dredging, and scour

14.5.3 At the Blackfriars Bridge Foreshore site some dredging may be required to allow barges to moor to the temporary works and to allow for the relocation of the present Blackfriars Millennium Pier. Dredging would be carried out during restricted periods to avoid sensitive periods for fish spawning (as outlined in the *CoCP* Part A Section 8). In addition, monitoring of the river morphology at this point would be carried out, to ensure no emergency dredging would be required, particularly during the sensitive periods. The proposed dredge volume at this site is estimated as 1,700m^3 at the main construction site and 2,500m^3 at the secondary site (Blackfriars Pier site) for the pier relocation. It has also been estimated that there would be a loss of 5% of the dredged material to the water column, and therefore an estimated 210m^3 (or 420t assuming an in-situ density of 2t per m^3) of sediment being released during the dredging operation.

14.5.4 Further 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[vi] . The proportion of this estimate that would originate from the Blackfriars Bridge Foreshore site is approximately 145t.

14.5.5 It is also possible that the temporary cofferdam would affect the river regime with the potential that localised increases in flow velocity could cause scour of the river bed and foreshore and could result in the mobilisation of suspended solids (see Section 14.2). 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).

14.5.6 The 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 (or 20,000m^3) of sediment passing the site four times a day during spring tides (HR Wallingford, 2006)[12]. 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

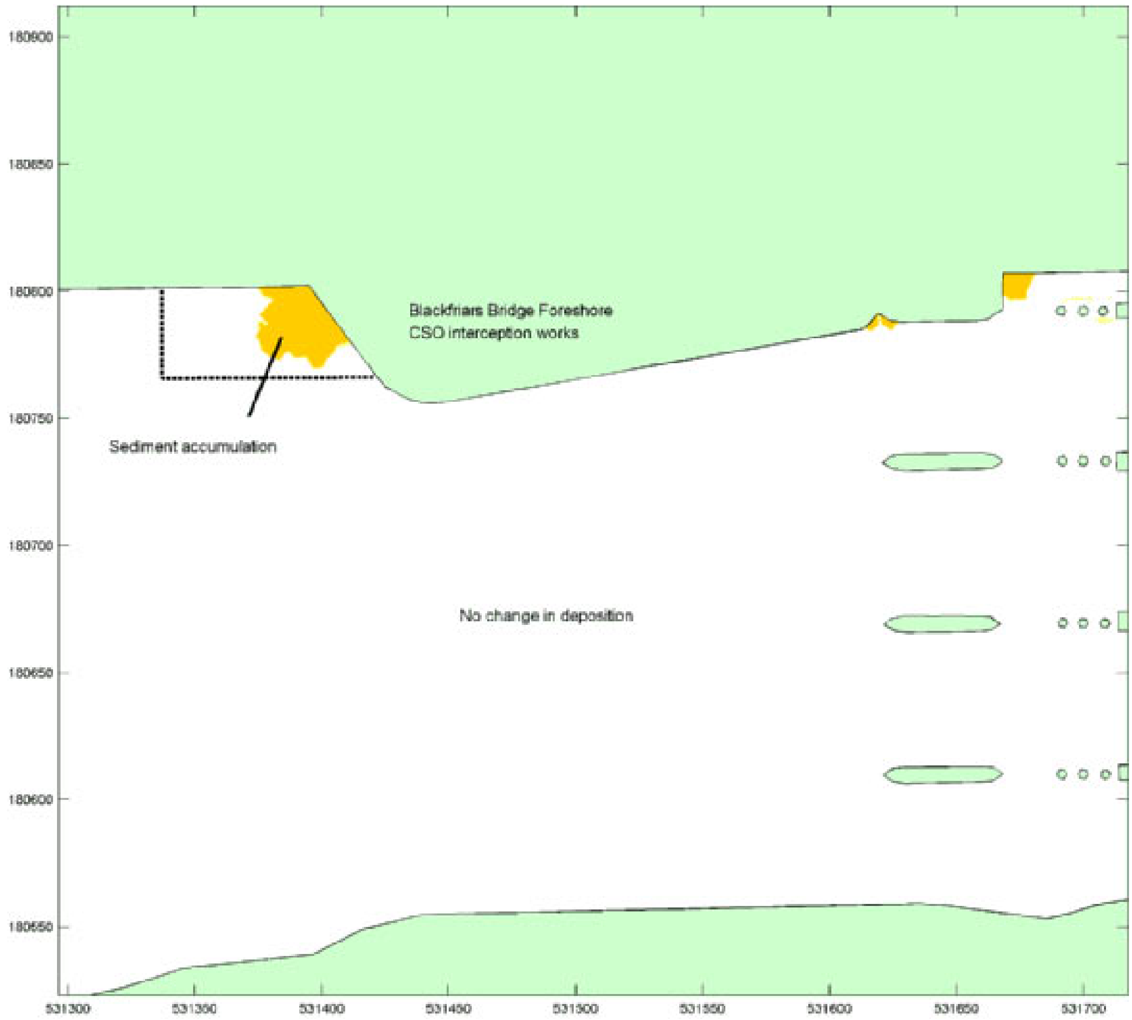
[vi] An assessment of the potential sediment losses anticipated from construction activities within the foreshore is provided in the *Habitats Regulation Assessment: No Significant Effects Report.*

resources (HR Wallingford, 2006)[13] and are therefore not considered further within the assessment.

Deposition

14.5.7 The temporary cofferdam would be likely to lead to changes in flows (velocities, directions) and cause changes in deposition of sediments around the Blackfriars Bridge 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 18 Plate 14.5.1.

Vol 18 Plate 14.5.1 Surface water – prediction deposition around temporary works at Blackfriars Bridge Foreshore site



14.5.8 Most deposition is likely to be localised and occur in newly created areas of slack water (as shown above on Vol 18 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.

14.5.9 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

14.5.10 The main pathways for surface water quality impacts during construction at the Blackfriars Bridge Foreshore site are as a result of the requirement for a cofferdam to be constructed in the river channel for the main construction work. 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. 14.2.8) should remove the impact pathway.

14.5.11 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

14.5.12 Contamination has been recorded in the near surface sediments, although overall the mobility of metal and PAH contaminants has been recorded to be low. 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.

14.5.13 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. 14.5.6) 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.

14.5.14 Therefore, there is considered to be no impact from this source and this is not considered further within this assessment.

Surface water drainage

14.5.15 Once constructed, the cofferdam area and the drop 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.

14.5.16 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 therefore not considered further within this assessment.

Debris accumulation

14.5.17 The temporary cofferdam and other structures at the Blackfriars Bridge Foreshore site may interact with Blackfriars Bridge and Blackfriars Millennium Pier 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 various structures in the vicinity of the Blackfriars Bridge Foreshore site working area.

Dewatering

14.5.18 Based on the geology at the site, the base of the drop shaft would require dewatering and or ground treatment. See Section 13 of this volume for further details on the dewatering requirements. Depending on the quality of the groundwater that is pumped out, there could be an impact on water quality of the tidal Thames.

14.5.19 Intrusive ground contamination testing has been carried out at and in the vicinity of the site, which did not identify contamination of the underlying groundwater. An assessment of potential on-site contamination is provided within Section 8 of this volume. Settlement of suspended solids within the dewatering would minimise the levels of any contaminants within the effluent, which tend to be associated with particulates. Additional treatment of the dewatering effluent, or remediation of groundwater, may also be carried out, if required. It is therefore considered that there is no pollution pathway and hence no impact from dewatering.

Construction effects

14.5.20 The potential surface water impacts identified above as a result of construction at Blackfriars Bridge 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 18 Table 14.4.1.

14.5.21 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.

14.5.22 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

14.5.23 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.

14.5.24 At the end of the construction, part of the riverbed would be reinstated following removal of the temporary structures. This is due to the natural circulation of sediments within the estuary and the accumulation of silt and mud that is likely to occur. The temporary change is 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**.

14.5.25 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

14.5.26 The change in flow regime of the tidal Thames due to the cofferdam construction may result in an area of slack ‘dead’ water between the construction area and the relocated Blackfriars Millennium Pier, where floating debris, oils and other pollutants could build up and reduce the amenity value of the river for recreational users.

14.5.27 A change in appearance and aesthetic quality of the tidal Thames in the near 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 Fleet Main CSO 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 Fleet Main CSO would substantially decrease (as a result of the capture of combined sewer overflows flow into the main tunnel) as follows:

a. the CSO would spill on average four times per year (19 times less than the operational base case)

b. the CSO would spill for an average duration of 14 hours (69 hours less than the operational base case)

c. the spill volume from the CSO would be approximately 37,000m^3 per year (534,000m^3 less than the operational base case).

14.6.3 The frequency, duration and volume of spills at Blackfriars Bridge Foreshore site would therefore be reduced by approximately 93% as a result of the operation of the Thames Tideway Tunnel project.

14.6.4 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 Fleet Main CSO would be a maximum of 16 days in the Typical Year (a reduction of up to 76 days of risk of exposure).

14.6.5 Similarly, the tonnage of sewage derived litter from the CSO can be expected to reduce by approximately 93%, from approximately 144t to approximately 9t, in the Typical Year.

14.6.6 The reduction in polluting load that would be discharged from the CSO with the project in place would be as follows:

a. the CSO would discharge 4,300kg of BOD in the Typical Year (35,700kg less than the operational base case)

b. the CSO would discharge 160kg of ammonia in the Typical Year (1,140kg less than the operational base case)

c. the CSO would discharge 650kg of TKN in the Typical Year (4,500kg less than the operational base case).

14.6.7 Catchment modelling of the 2080 development case (to account for the effects of climate change and predicted increases in population) predicts that by 2080 with the operational Thames Tideway Tunnel project, the frequency, duration and volume of the Fleet Main CSO would be the following:

a. the CSO would spill on average three times per year (once less than the Year 1 of operation development case)

b. the CSO would spill for an average duration of 15 hours (one hour more than the Year 1 of operation development case)

c. the spill volume from the CSO would be approximately 89,000m^3 per year (52,000m^3 more than the Year 1 of operation development case).

14.6.8 In summary the model predicts that in the 2080 development case scenario the Fleet Main CSO at Blackfriars Bridge Foreshore site would reduce in 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.

14.6.9 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. As these water quality changes would be realised across the tidal Thames they have been assessed in Vol 3 Section 14 and climate change is not considered further within the assessment.

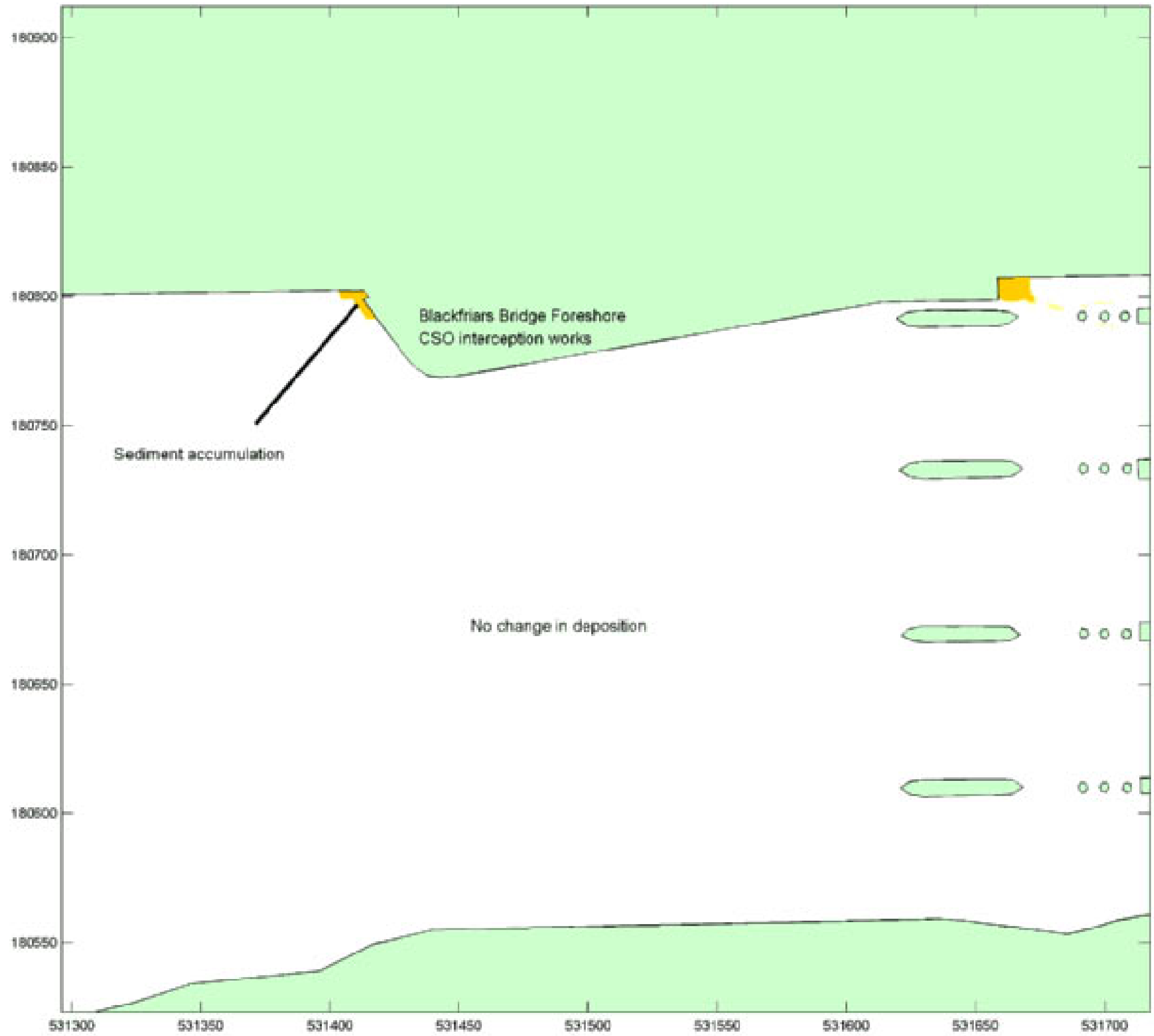
Permanent land take and morphological changes

14.6.10 In order to accommodate the permanent works at the Blackfriars Bridge Foreshore site, construction of a permanent structure within the river channel would be required, as described in Section 3 of this volume. The permanent structure could affect the river regime with the potential that localised increases in flow velocity could 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 para. 14.2.14 and scour is not considered further with the assessment.

Deposition

14.6.11 The permanent works cofferdam would be likely to lead to changes in flows (velocities, directions) and cause changes in deposition of sediments around the Blackfriars Bridge 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 18 Plate 14.6.1.

Vol 18 Plate 14.6.1 Surface water – prediction deposition around permanent works at Blackfriars Bridge Foreshore site



14.6.12 Most deposition is likely to be localised (as shown above in Vol 18 Plate 14.6.1) 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.

14.6.13 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 Fleet Main CSO spills

14.6.14 The reduction in spills from the Fleet Main CSO would represent an important contribution towards

a. meeting the requirements of the UWWTD[14] in relation to the Fleet Main CSO

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.

14.6.15 Therefore, the reduction in spills would result in 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 Blackfriars Bridge Foreshore site also depends on the project-wide improvements, as documented in Vol 3.

14.6.16 The associated reduction in exposure to pathogens would greatly improve the conditions for recreational users of the tidal Thames around Blackfriars Bridge Foreshore site, 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.

14.6.17 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. As explained in Section 14.4, an assessment of the amenity effects of the sewage litter is given in Vol 3 Section 10.

Permanent land take and morphological changes

14.6.18 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 and channel dredging. 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**.

14.6.19 Impacts on channel morphology can also have an effect on ecological receptors, by changing habitat availability. This effect 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 As explained in Section 14.3, no developments have been identified that would be under construction during Site Year 1 of construction or operation, therefore a cumulative effects assessment has not been undertaken. No significant cumulative effects have therefore been identified for the construction or operational phases at this site. The effects on surface water would therefore 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 no 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

Vol 18 Table 14.10.1 Surface water – construction assessment summary

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Thames Upper and Thames Middle	Temporary changes to channel morphology (cofferdam and associated scour protection construction)	Minor adverse	None	Minor adverse
Thames Upper and 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 Upper and Thames Middle	Compliance with UWWTD and WFD. Improved water quality in the vicinity of the Fleet Main CSO by reduced pollutant loading and no reduction of DO levels due to reduced spill frequency, duration and volume from the Fleet Main CSO	Major beneficial	None	Major beneficial
Thames Upper and Thames Middle	Risk of exposure days to pathogens would be reduced to a maximum of 16 days in the Typical Year (a reduction of up to 76 days of risk of exposure)	Moderate beneficial	None	Moderate beneficial
Thames Upper and Thames Middle	Sewage derived litter discharge at Fleet Main CSO would be reduced by approximately 93% improving the aesthetic quality of the river locally	Moderate beneficial	None	Moderate beneficial
Thames Upper and 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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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.18**

Volume 18 Blackfriars Bridge 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 18: Blackfriars Bridge 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 Blackfriars Bridge 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 Volume 2 Environmental assessment methodology Section 15.3.

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 18 Blackfriars Bridge 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 elements of the proposed development relevant 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 i.e., groundwater and surface water. The assessment of effects on groundwater and surface water is presented in Section 13 and Section 14 of this volume respectively.

15.1.5 A project-wide FRA has been undertaken and is presented in Volume 3 Project-wide effects 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 18 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 Blackfriars Bridge 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 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 Blackfriars Bridge Foreshore 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 During the construction phase the following elements are proposed that are relevant to flood risk:

a. A cofferdam would be constructed in the foreshore to the same height as the existing flood defence wall.

b. A piled deck would be constructed to the west of the cofferdam to allow barge mooring and the loading and unloading of material.

c. A section of the existing tidal Thames flood defence wall situated between the proposed site and the embankment would be removed to allow site access.

d. The Blackfriars Millennium Pier would also be removed and replaced downstream, to the east of Blackfriars Bridge.

e. The operation of the existing Fleet Main combined sewer overflow (CSO) would be maintained to the same capacity throughout the construction period by an extension through the cofferdam using flumes and flap valves.

Code of Construction Practice

15.2.3 Appropriate guidance regarding flood defence construction and emergency planning is 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). The relevant measures are summarised below.

15.2.4 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.

15.2.5 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

15.2.6 As part of the permanent works the following elements are relevant to flood risk:

a. A new flood defence wall. 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.

b. The proposed development would intercept the existing Fleet Main CSO and divert it to the tunnel via a drop shaft. A new CSO would be

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[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.

constructed which would spill only when the main tunnel reaches capacity or is unavailable.

c. A series of terraced ‘rainwater gardens’ would provide methods for rain water harvesting and water recycling. Rainwater would be harvested from the surrounding vegetated roofs and hard pedestrianized surfaces and collected in open channels, then pumped to the top terrace to be purified and cleansed through the ‘rainwater gardens’ prior to entering the pools and water features. As the site is adjacent to the tidal Thames, excess surface water runoff from this system would be discharged directly into the tidal Thames.

15.3 Assessment of flood risk

Introduction

15.3.1 The NPS requires that all potential sources of flooding that could affect the proposed development are considered.

15.3.2 This assessment is based on a screening exercise that identified relevant potential flood sources and pathways. The tidal and fluvial 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 Section 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 risk based on the flood zones

15.3.5 The Blackfriars Bridge Foreshore site is situated within the tidal foreshore of the River Thames (with the exception of areas of the pavement along Victoria Embankment and Paul’s Walk), adjacent to the northern river bank, underneath and to the west of Blackfriars Bridge. 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 18 Figure 15.3.1 (see separate volume of figures).

15.3.6 As the majority of 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 Vol 2 Section 15).

Existing tidal defences

15.3.7 A raised flood defence wall is aligned along the boundary between the tidal Thames and Paul's Walk on Victoria Embankment. The defence wall is landward of the majority 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 Tidal Barrier located approximately 15km downstream.

15.3.8 The EA stated that the statutory flood defence level relevant to the Blackfriars Bridge Foreshore site is 5.41m Above Ordnance Datum (AOD). The National Flood and Coastal Defence Database (NFCDD) (EA, 2011)[5] identified the crest level of the flood defences adjacent to the site along at between 5.41-5.74m AOD.

15.3.9 Condition surveys of the flood defences carried out by the EA in April 2011[6] state that the flood defences at this location are overall in good condition (Grade 2), with some areas in fair condition (Grade 3).

15.3.10 The adjacent land behind the foreshore part of the 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.

15.3.11 The Strategic Flood Risk Assessment (SFRA) for the City of London (Mouchel Parkman, 2007)[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 foreshore is designated in the SFRA as an area of medium (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, as this would be able to empty over a number of low tides. Further detail regarding residual risk is provided within para. 15.5.5 and in Vol 3 Section 15.

Tidal flood level modelling

15.3.12 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.

15.3.13 The EA Thames Tidal Defences Joint Probability Extreme Water Level Study (2008) (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.

[ii] Designated using a combination of flood depth, flow velocity and debris as per the Defra publication 'Flood Risks to People

[iii] A flood with a 0.5% Annual Exceedance Probability (AEP) has a one in 200 year probability of occurring in a given year

15.3.14 Vol 18 Table 15.3.1 presents the modelled tidal levels from this study for model node 2.34 which is the most relevant (ie, closest) to the site (Vol 18 Figure 15.3.1). 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 Section 15), therefore the 2005 scenario (ie, the present day scenario provided by the EA) produces the highest water level.

15.3.15 Vol 18 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 site is protected from tidal flooding to the statutory level.

Vol 18 Table 15.3.1 Flood risk – modelled water levels

Return period	Flood level (mAOD)	Statutory flood defence level (mAOD)
0.5% AEP (2005)	4.95	5.41
0.5% AEP (2107)	4.94	

Tidal risk from the proposed development

New tidal defences

15.3.16 The presence of new permanent structures within the foreshore has the potential to influence the flood risk to the site itself and to the surrounding environment.

15.3.17 The proposed development includes building a new flood defence to the existing statutory level. As a result, the majority of the site which is currently located within the functional floodplain of the tidal Thames and is in Flood Zone 3b would be protected by defences and subject to residual risk only, in the event of a breach or overtopping of the flood defences. Potential risks are described further in paras. 15.3.18 to 15.3.30 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 machines (TBMs) and other construction methods including shaft construction, 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 could potentially affect the flood 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.

15.3.20 A potential settlement of between 1mm and 88mm across the river walls is estimated to occur at the site (based on information provided by Thames Water). The flood defence levels following settlement is estimated to range from 5.40mAOD to 5.74mAOD. This could therefore result in one section of the river wall falling below the statutory flood defence levels as a result of this degree of settlement.

15.3.21 However, it should be noted that the section of the river wall where the maximum degree of settlement is predicted would be replaced as part of the proposals.

15.3.22 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 additional surcharge loading, increased water differential and 'Burland' damage[iv].

Flood defence line

15.3.23 The construction of a proposed replacement floating pier to the east of the site would not influence the flood risk to the local flood defences as access to the pier would be placed over the existing defences present along the Embankment.

15.3.24 Both temporary and permanent works for the flood defences have the potential to influence 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 level 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

15.3.25 The TE2100 Plan 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 Plan 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.

15.3.26 A scour summary report ((Vol.3, Appendix L3) 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 tidal Thames including the Blackfriars Bridge Foreshore site.

15.3.27 Scour is predicted at the Blackfriars Bridge Foreshore site to be greatest during construction with maximum estimated scour depths due to temporary works of up to 0.5m. The contraction scour has been estimated during construction at 0.5m across the river bed and at 0.5m at the adjacent river walls.

[iv] Tensile strains in gravity wall due to longitudinal differential settlement.

15.3.28 During the permanent works local scour depths of up to 0.5m are predicted around the permanent works. Contraction scour has been estimated at 0.5m.

15.3.29 Both the temporary and permanent works have therefore 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

15.3.30 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.

15.3.31 The Blackfriars Bridge 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.15.3.8 the flood defences at this site are at or above the statutory level. When the flood defence levels are compared to the 1 in 200 year tidal level for the year 2107 these would provide between 0.47-0.8m 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.

15.3.32 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 risk based on the flood zones

15.3.33 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 Blackfriars Bridge Foreshore site is largely located within Flood Zone 3b, and as the extent of 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 Section 15.

15.3.34 The only other fluvial system within the vicinity of the site is the culverted River Fleet. This outfalls under Blackfriars Bridge and has an outfall structure approximately 3.7m wide. The culverted section of the River Fleet has been adopted by Thames Water (now the Fleet sewer catchment) and is therefore considered further as a potential flood risk from the local sewer system rather than the fluvial system.

Fluvial flood risk from the proposed development

15.3.35 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

15.3.36 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.

15.3.37 As part of the Drain London Project[v] a *Surface Water Management Plan* (*SWMP*) was prepared for the City of London (GLA, 2012)[10]. This identifies the land adjacent to the foreshore, along the tidal Thames Embankment, to be located within a Critical Drainage Area (CDA)[vi], which indicates that it may be relatively more susceptible to surface water flooding than other areas in the City. Modelling results for a 1 in 100 year (1% AEP) rainfall event plus climate change allowance show potential surface water flooding of 0.1-0.5m deep adjacent to the foreshore.

15.3.38 Road levels along the Victoria Embankment, to the west of the site, are approximately 4.5mAOD and slope slightly towards the river wall to the south. Towards Blackfriars Bridge, the road separates to form the Blackfriars underpass, and slip roads either side. The slip roads rise to approximately 9.9mAOD where they join Blackfriars Bridge. Immediately in front of the river wall, Paul's Walk runs under Blackfriars Bridge and at a lower level of approximately 4.7mAOD. This rises to 6mAOD where it meets the Victoria Embankment to the West. To the east of Blackfriars Bridge and Blackfriars Railway Bridge, Paul's Walkway continues at a level of 4.7mAOD. White Lion Hill, to the north of the walkway, slopes from 5.5mAOD at the junction of Blackfriars Underpass to 9mAOD where it changes direction to the north. Surface water from the surrounding hard standing areas would be likely drain towards and accumulate in the underpass and Paul's Walkway behind the river wall where the road levels are lowest.

15.3.39 Due to the presence of an overland flow route and having the adjacent areas been identified as having a potential flood depth ranging between 0.1-0.5m, the flood risk to the site from this source of flooding is considered to be medium (see Vol 2 Section 15).

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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.

Surface water flood risk from the proposed development

15.3.40 An assessment of the likely significant effects of surface water runoff from the Blackfriars Bridge 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 A series of terraced 'rainwater gardens' are proposed on the permanent site to illustrate sustainable methods for rain water harvesting and recycling water. Rainwater would be harvested from the surrounding vegetated roofs and hard pedestrianized surfaces and collected in open channels, then pumped to the top terrace to be purified and cleansed through the 'rainwater gardens' prior to entering the pools and water features. As the site is adjacent to the tidal Thames, excess surface water runoff from this system would be discharged directly into the tidal Thames.

15.3.43 The foreshore area of the 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), excess surface water runoff from the proposed site drainage 'terraces' would also be discharged directly to the River Thames. Due to the tidal nature of the receiving watercourse, surface water runoff rates to the tidal Thames would not increase surface water flood risk to the site or surrounding area and would therefore not require attenuation prior to discharge.

15.3.44 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.

15.3.45 Following the implementation of the above drainage measures the risk of flooding from this source as a result of the proposed development would be unchanged and remain as medium.

Groundwater flood risk to the proposed development

15.3.46 Groundwater flooding occurs where groundwater levels rise above ground surface levels. Groundwater levels have been recorded by Thames Water for the nearest borehole SR1061A (approx 0.4km to the west of the site along the Embankment). At this location the water level of the upper aquifer, in the river terrace deposits, has an average value of 6.16m below ground level (bgl). This level was recorded from October 2009 and October 2012.

15.3.47 Given the depth of groundwater in the vicinity, the risk of groundwater flooding is considered to be low (see Vol 2 Section 15).

Groundwater flood risk from the proposed development

15.3.48 An assessment of the likely significant effects on groundwater at the Blackfriars Bridge Foreshore site is provided in Section 13 of this volume.

15.3.49 The CSO drop shaft would pass through made ground, river terrace deposits, London Clay, Harwich Formation, Lambeth Group and Thanet Sands. Dewatering of the lower aquifer is anticipated during the construction phase to manage the groundwater levels to enable construction and this would reduce the risk of flooding from this source. Groundwater brought to the surface as a result of dewatering during construction would be pumped from the construction site to the tidal Thames after treatment.

15.3.50 The impact of the CSO drop shaft within the upper aquifer has been assessed within the groundwater assessment as resulting in a predicted rise in water levels of approximately 0.3m and 0.1m during the construction and operational phase respectively. If these increases were to arise, they would not significantly alter the likelihood of groundwater rising to the surface as groundwater levels would remain approximately 5.86m below ground surface. As a result, it is considered that there is no subsequent increase in flood risk from this source as a result of the proposed development and the risk from groundwater flooding would remain as low.

Sewers flood risk to the proposed development

15.3.51 Sewer flooding arises when the local sewer network is exceeded or a problem arises such as a blockage or fracture.

15.3.52 Two combined sewer systems which run within the vicinity of the site are the Low Level Sewer No. 1 and the Fleet Main. The Fleet Main CSO discharges beneath Blackfriars Bridge and would be intercepted as part of the project.

15.3.53 The northern Low Level Sewer No.1 (2515mm diameter) runs along the north bank of the tidal Thames and was constructed as a part of the Victoria Embankment river wall. It outfalls at Beckton Sewage Treatment Works via Abbey Mills Pumping Station and the Northern Outfall Sewer. Within the proximity of the site there are several connections to the Low Level Sewer No. 1 including a combined sewer (1219mm by 813mm) draining from Carmelite Street to the north.

15.3.54 The Fleet Main catchment near to the site includes the Fleet Main and the Fleet Storm Relief sewer, which join beneath the road junction to the north of Blackfriars Bridge. During storm events, the Fleet Main catchment overflows into the Tidal Thames beneath Blackfriars Road Bridge via twin 2438mm by 2134mm outfalls which comprise the Fleet Main CSO. Two smaller combined sewers from the west and east (both with diameters of 229mm) connect to the Fleet Main CSO under Blackfriars bridge.

15.3.55 The capacity of the Fleet Main is unlikely to be exceeded as it is designed to discharge via the outfall and therefore the flood risk from this sewer is low. Should the capacity of the low level sewer be exceeded, sewage could surcharge through gullies and manholes along the reach of the sewer. The topography of the site suggests that any sewage would follow the path of the Blackfriars underpass, or along Victoria Embankment.

15.3.56 The City of London SFRA[3] contains maps of 'critical sewer flooding locations' based upon information provided by the City of London Corporation. Victoria Embankment, located to the north of the site, is identified to lie within a 'critical sewer flooding location'.

15.3.57 Thames Water flooding records (Thames Water, 2012)[11] show that there have been 7 records of flooding within 200m of the site since 1990.

15.3.58 Therefore due to the number of previous sewer flooding incidents and the presence of potential pathways for water to the site, the risk of flooding from this source is considered to be high (see Vol 2 Section 15).

Sewers flood risk from the proposed development

15.3.59 Following construction of the proposed development, the northern Low Level Sewer No. 1 would be connected to the main tunnel, which along with connection to the northern Low Level Sewer No. 1 at Victoria Embankment Foreshore and Chelsea Embankment Foreshore would indirectly control 10 CSOs.

15.3.60 It is proposed that a connection would be made to the northern Low Level Sewer No.1 sewer where it meets Pauls Walk, so that flows are diverted to the main tunnel via the Blackfriars Bridge Foreshore CSO shaft at this site. To enable this, the existing sewer would be exposed during the construction phase. An overflow weir would be constructed on the northern Low Level Sewer No. 1 to control flows from this. A connection culvert would also be constructed from the weir chamber to the drop shaft connecting to the main tunnel. The flood risk during this phase would be managed using design measures described in Section 15.4.

15.3.61 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.

15.3.62 At present sewage discharges from the Fleet Main CSO when the capacity of the Fleet system 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 connecting culvert and discharge to the river. The design would ensure that the River Fleet upstream head is not increased for a range of return period events.

15.3.63 Following the construction of the proposed development the risk of flooding from this source would be unchanged and therefore would remain high.

[vii] The base case scenario comprises the sewage treatment works (STW) Improvements and Lee Tunnel in 2020s.

Artificial sources of flood risk to and from the development

15.3.64 There are no nearby artificial flood sources eg, canals, reservoirs, which could lead to flooding of the site.

15.3.65 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 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 would have the potential to affect the integrity of these 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 may include restricting loading above the existing river wall. Where there are potential effects from increased water differential, options may include propping the wall from the temporary cofferdam. It is envisaged that 'Burland' damage due to ground movement would be mitigated using pre and post construction survey, monitoring and if necessary reactive repair.

15.4.4 As discussed in para. 15.3.24 a cofferdam would be constructed to the same height as the existing flood defence level. This would ensure that the current level of flood protection is maintained during construction. Further information is included in the *CoCP* (Section 8).

15.4.5 The construction of a replacement floating pier to the east of the site would not have any impacts on the local flood defences as access to the pier would be placed over the existing defences present along the Embankment. Care would be taken during the construction phase to ensure that existing defences are protected as detailed 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 area would be protected from flooding through the provision of a new flood defence wall as outlined in para. 15.3.24. This would be located along the periphery of the operational area and would tie into existing flood defences, providing a continuous defence line along the Embankment at all times.

15.4.11 The new defence wall would be designed to ensure that future flood defence raising can be achieved to meet the TE2100 requirements.

15.4.12 As the new flood defence wall would be constructed to the same height as 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. 15.5.6 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

15.4.13 As discussed in para. 15.3.30, 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

15.4.14 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.

15.4.15 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 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

15.4.16 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

15.4.17 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

15.4.18 As outlined in para. 15.3.42 it is intended to discharge excess surface water from the proposed drainage 'terraces' 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

15.4.19 As described in para. 15.3.42, surface water runoff from the proposed site would be managed through a series of terraces demonstrating sustainable methods for harvesting and recycling water. Excess surface water 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

15.4.20 Groundwater monitoring is proposed during construction and operation. Groundwater resulting from the dewatering during construction would be pumped to the River Thames. Further measures regarding dewatering and maintaining groundwater levels are described in Section 13 of this volume.

Sewers

Construction

15.4.21 There are no proposed diversions of the existing sewer network for the site other than for the primary purpose of the proposed development. The operation of the Fleet Main CSO and the northern Low Level No. 1 sewer would be maintained to the same capacity using flumes and flap valves and extended through the cofferdam during the construction period.

Operation

15.4.22 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 connection culvert and discharge to the river. The design would ensure that flood risk is not increased for a range of return period events.

15.5 Assessment summary

Flood risk

15.5.1 The majority of the Blackfriars Bridge 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.

15.5.3 Vol 18 Table 15.5.1 provides a summary of the findings of the FRA undertaken for this site.

Residual risk to the development

15.5.4 The residual risk to the site is the risk that remains after all design measures have been incorporated.

15.5.5 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.

15.5.6 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

15.5.7 Following the incorporation of the design measures outlined in Vol 18 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.

Vol 18 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). Access to pier over defences. Monitoring of scour and mitigation if trigger value exceeded. Scour mitigation 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 (but risk is residual only[viii])
Fluvial	tidal Thames	Very high	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.	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)

[viii] *indicate the flood risk is residual ie in the event of a failure or overtopping of flood defences*

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
			Scour mitigation measures for permanent works Monitoring of flood defence levels and repaired as required to maintain existing crest level.		
Surface water	Surrounding area	Medium	Site drainage in accordance 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	Dewatering during construction. Monitoring proposed during construction and operation.	No increase in groundwater flood risk as a result of proposed development.	Low
Sewers	Local drainage system	High	CSO maintained with flumes and flap valves during construction. Flows diverted to the main tunnel.	No increase in sewers flood risk as a result of proposed development.	High
Artificial sources	None	Not applicable	Not applicable	Not applicable	Not applicable

** Definitions of these classifications are included in Vol 2 Section 15*

() indicate the flood risk is residual ie in the event of a failure or overtopping of flood defences

References

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