Thames Tideway Tunnel
Thames Water Utilities Limited

Thames Water

Development Consent Order

Application Reference Number: WWO10001

Documents for Certification
September 2014

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

Lindsay Speed   Sarah Fairbrother

September 2014

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.24**

Volume 24: Greenwich Pumping Station site assessment

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

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January 2013

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Volume 24: Greenwich Pumping Station 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 Greenwich Pumping Station site.

1.1.2 The proposal at this site is to intercept the existing combined sewer overflow (CSO), which currently discharges approximately 51 times in a typical year. The total volume discharged is approximately 8,320,000m^3 per typical year. This would require a CSO drop shaft to be constructed and then a tunnel boring machine (TBM) would be driven from this site to Chambers Wharf to form the Greenwich connection tunnel.

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

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

1.1.5 Figures and appendices for this site are appended separately (see Vol. 24 Greenwich Pumping Station figures and Vol.24 Greenwich Pumping Station appendices). In addition, there is a separate glossary and abbreviations document which explains technical terms used within this assessment.

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Volume 24: Greenwich Pumping Station site assessment

Section 2: Site context

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2 Site context

2.1.1 The proposed development site is located in the Royal Borough (RB) of Greenwich and is close to the London Borough (LB) of Lewisham to the west of the site. The site comprises the most of the existing Thames Water pumping station and Phoenix Wharf. The site's extent is defined by the limits of land to be acquired or used (LLAU) and would cover an area of approximately 2.14 hectares. The site context and location is indicated in Vol 24 Figure 2.1.1 (see separate volume of figures).

2.1.2 The Greenwich Pumping Station site is bisected by the elevated Dockland Light Railway (DLR) and a Network Rail viaduct which traverse the site from east to west.

2.1.3 The area north of the railway contains Phoenix Wharf which is industrial in nature. This area is bounded by Brookmarsh Trading estate to the north, Norman Road and the Greenwich Centre Business Park to the east and Deptford Creek to the west.

2.1.4 The area south of the railways comprises the existing Thames Water Greenwich Pumping Station. Norman Road forms the eastern boundary of the site with the currently disused Greenwich Industrial estate situated beyond this. The south-eastern boundary is formed by Norman House while residential properties lie to the south of the site, adjacent to Greenwich High Street. Deptford Creek is the western boundary of the site. Vol 24 Plate 2.1.1 below provides an aerial view of the site.

Vol 24 Plate 2.1.1 Greenwich Pumping Station site – aerial photograph

2.1.5 Within the site there is mainly hardstanding with patches of scrubland. The general pattern of existing land uses within and around the site is shown in Vol 24 Figure 2.1.2 (see separate volume of figures).

2.1.6 The site is currently accessed from Norman Road (B208), and Greenwich High Road (A206). There are no Underground stations in the surrounding area. Greenwich Station is approximately 300m walking distance to the east of the site. Both Docklands Light Railway (DLR) and National Rail services operate from this station. The nearest bus stop to the site is located 55m walking distance to the south on Greenwich High Street. A sign-posted shared footpath and cycle route runs through the site crossing under the DLR. This is a public right of way (PRoW).

2.1.7 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 residential house within public house adjacent to the south hoarding boundary
   ii recently completed and occupied residential development next to coal sheds to southwest of hoarding
b. educational
   i Lewisham college (Deptford campus) – 220m to the south of the hoarding
c. commercial
   i newsagents – adjacent to the south hoarding boundary
   ii Brookmarsh Industrial Estate – adjacent to north hoarding boundary
d. recreational
   i Greenwich west community and arts centre – 95m to the northeast of the hoarding
e. other
   i Devonshire Drive Baptist Church – 115m south east of the hoarding.

2.1.8 Environmental designations for the site and immediate surrounds are shown in Volume 24 Figure 2.1.3 (see separate volume of figures).

2.1.9 The site is within the Greenwich air quality management area (AQMA) declared for both nitrogen dioxide (NO_2) and particulate matter (PM_{10}).

2.1.10 Deptford Creek, as a tributary of the River Thames, is designated a Site of Importance for Nature Conservation (SINC) (Grade III of Metropolitan importance). Deptford Creek is also a SINC at the Borough level. The Creekside Centre, which is located west of the site contains an environmental centre and is also designated as SINC at the Local level. There are two Local Nature Reserves (LNRs) within 1km of the site, namely the Sue Godfrey Nature Park and the Brookmill Park. Brookmill Park is also part of the River Ravensbourne (a tributary of the River Thames located south of the site) and Brookmill Park SINC (of Borough importance). The Ashburnham Triangle Conservation Area lies to the south of Greenwich High Road. In addition, the Deptford Creekside Conservation Area lies to the west of the site, adjacent to Deptford Creek.

2.1.11 The site contains four Grade II listed buildings, including the railway viaduct that crosses the centre of the site and three buildings associated with the original Deptford (Greenwich) Pumping Station, which was built in the early 1860s. These include the east and west beam engine houses, a linking boiler house (now used as offices) and the associated coal sheds, located in the southern half of the site. Vol 24 Plate 2.1.2 shows the listed pumping station buildings in the south of the site.

Vol 24 Plate 2.1.2 Greenwich Pumping Station − photograph of the listed Pumping Station buildings

2.1.12 The site lies within an extensive Archaeological Priority Area as designated by the RB of Greenwich.

2.1.13 There are no tree preservation orders (TPOs) in effect on or adjacent to the site.

2.1.14 The site and surrounding area has a history of industrial use (including engineering, gas works and factories). The CSO drop shaft would pass through Made Ground, Alluvium, River Terrace Deposits, Lambeth group, Thanet sand and Chalk at depth (principal aquifer).

2.1.15 The site is located within the defended tidal Flood Zone 3 of the River Thames and Deptford Creek.

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Volume 24: Greenwich Pumping Station site assessment

Section 3: Proposed development

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3 Proposed development

3.1 Overview

3.1.1 The proposed development at Greenwich Pumping Station would intercept the existing combined sewer overflow (CSO). The Greenwich connection tunnel would also be driven from this site to Chambers Wharf. A CSO drop shaft would be constructed and there would also be an interception chamber and hydraulic structures/chambers with access cover(s). Other structures would include culverts to modify, connect, control, ventilate access and intercept flows from the existing Greenwich Pumping Station CSO and divert them into the Greenwich connection tunnel. Once the drop shaft is constructed, the tunnel boring machine (TBM) would be launched through the base of the drop shaft north via Deptford Church Street and Earl Pumping Station to Chambers Wharf.

3.1.2 The LLAU defines the geographic extent of the proposals for which development consent is sought.

3.1.3 This section of the assessment presents information on 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 include the assumed programme and typical construction activities. Section 3.4 sets out operational assumptions in terms of operational structures and typical maintenance regime. These construction and operational assumptions underpin the assessment.

3.1.4 Other development may become operational in advance of or during the Thames Tideway Tunnel project thereby changing the baseline conditions. In order to undertake an accurate assessment it is necessary to compare the predicted situation with the Thames Tideway Tunnel project in place with this future baseline conditions (‘base case’) (rather than comparing it with the current conditions). In addition, other development 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 24 Appendix N. The methodology for identifying these schemes is explained in Volume 2 Section 3.8. Finally, Section 3.6 describes how the development at this site has evolved and any alternatives considered.

3.2 Defined project

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

3.2.2 Vol 24 Table 3.2.1 below sets out the documents and plans for which consent is sought and which have been assessed.

Vol 24 Table 3.2.1 Greenwich Pumping Station − plans and documents defining the proposed development

Document/plan title	Status	Location
Proposed schedule of works	For approval	Schedule 1 of *The Draft Thames Water Utilities Limited (Thames Tideway Tunnel) Development Consent Order 201[ ] (Draft DCO* (and extracts below)
Site works parameter plan	For approval	Vol 24 Greenwich Pumping Station figures – Section 1
Demolition and site clearance plans	For approval	Vol 24 Greenwich Pumping Station figures – Section 1
Access plan	For approval	Vol 24 Greenwich Pumping Station figures – Section 1
Existing floor plan with extent of loss	For information – but maximum extent of loss of listed structures is for approval	Vol 24 Greenwich Pumping Station figures – Section 1
Listed building internal elevations with extent of loss	For information – but maximum extent of loss of listed structures is for approval	Vol 24 Greenwich Pumping Station figures – Section 1
As existing beam engine house south elevation with extent of loss	For information – but maximum extent of loss of listed structures is for approval	Vol 24 Greenwich Pumping Station figures – Section 1
Proposed floor plan	Indicative	Vol 24 Greenwich Pumping Station figures – Section 1
Proposed beam engine house east/north/south elevations	Indicative	Vol 24 Greenwich Pumping Station figures – Section 1
Sections BB and CC	Indicative	Vol 24 Greenwich Pumping Station figures – Section 1

Listed structure interface - entrance door; windows	Indicative	Vol 24 Greenwich Pumping Station figures – Section 1
Proposed site features plan	Illustrative- but the scale of above ground structures is indicative	Vol 24 Greenwich Pumping Station figures – Section 1
Design Principles: Generic	For approval	*Design Principles* report Section 3 (see Vol 1 Appendix B)
Design Principles: Site Specific principles (Greenwich Pumping Station)	For approval	*Design Principles* report Section 4.20 (see Vol 1 Appendix B)
Code of Construction Practice (CoCP) Part A: General Requirements	For approval	*CoCP* Part A (see Vol 1 Appendix A)
Code of Construction Practice (CoCP) Part B: Site specific Requirements (Greenwich Pumping Station)	For approval	*CoCP* Part B Greenwich Pumping Station (see Vol 1 Appendix A)

Description of the proposed works

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

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

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

Nationally significant infrastructure project

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

a. **Work No. 23a**: Greenwich Pumping Station CSO drop shaft – A shaft with an internal diameter of 17 metres (which extends 1 metre above the proposed ground level) and which has a depth (to invert level) of 46 metres (measured from the top of Work No. 23a)

b. **Work No. 20**: Greenwich connection tunnel – A tunnel with an internal diameter of 5.0 metres and 4610 metres in length between Chambers Wharf main tunnel site (Work No. 19a) and Greenwich Pumping Station CSO drop shaft (Work No. 23a).

Associated development

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

a. **Work No. 23b**: Greenwich Pumping Station associated development - Works to create a tunnel drive site for use in constructing and operating the Greenwich connection tunnel (Work No. 20), including the following above and below ground works and structures:

  i demolition of existing industrial buildings and other structures, works to protect existing river wall to the north and south of the Network Rail viaduct, and ground preparation works including land remediation

  ii provision of areas for [assembly of plant and machinery], storage of construction materials and excavated materials including temporary enclosures and workshops, concrete batching plant, fixed and mobile craneage, plant and equipment for ground treatment and dewatering and facilities and equipment for the processing of excavated materials from shaft and tunnel excavation including silos, tanks and conveyors (with and without noise enclosures), provision of power supplies (including substations) and other utilities including temporary buildings and other means of enclosure, office and welfare facilities and installations and equipment for monitoring the construction activity

  iii construction of an acoustic enclosure building(s) over Work No. 23a for use in association with the construction of Work No. 20

b. **Work No. 23c**: Greenwich Pumping Station associated development – Works to intercept and divert flow from the Greenwich Pumping Station CSO to the Greenwich CSO drop shaft (Work No. 23a) and into the Greenwich connection tunnel (Work No. 20) including the following above and below ground works and structures:

  i construction of an interception chamber, CSO overflow structures, hydraulic structures, chambers with access covers and other structures including culverts, pipes and ducts to modify, connect, control, ventilate, de-aerate, and intercept flow

- ii alterations to the listed east Beam Engine House (including the replacement of the existing ground floor), to accommodate ventilation equipment (including filters and fans) and including the dismantling, storage and reconstruction of entrance steps
- iii construction of brown roof, including handrail and ventilation structure on top of Work No. 23a
- iv construction of structures for air management plant and equipment including filters, fans, and ventilation columns and associated below ground ducts and chambers
- v installation of electrical control equipment within the listed Greenwich Pumping Station buildings
- vi construction of pits, chambers, ducts and pipes for cables, hydraulic pipelines, utility connections, utility diversions and drainage, including facilities for drainage attenuation
- vii alteration of accesses off Norman Road and Greenwich High Road
- viii provision of security fencing and gates
- ix alteration of existing accesses from Norman Road
- x construction of temporary access off Norman Road and subsequent removal and reinstatement of original highway layout.

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

a. drop shaft and access steps = 1.5m

b. ventilation structure(s) = 5.0m

c. interception and valve chambers = 1.5m

3.2.7 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.

3.2.8 The works defined by bullets c, k and m (in the list above) are not considered likely to be applicable to the works proposed to this site. It is also considered unlikely that the works at this site would require the removal or creation of temporary coach parking bays (see bullet d).

Ancillary works

3.2.9 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 of the *Draft DCO*.

3.2.10 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

3.2.1 The works defined by bullet h (in the list above) are not considered likely to be applicable to the works proposed to this site.

Design principles

3.2.2 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, permanent structures).

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

3.2.4 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.

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

Site features and landscaping

3.2.6 The above-ground structures are shown at indicative scale on the Proposed landscape plan (see separate volume of figures – Section 1) and the scales of these structures (in addition to the defined heights) have been considered within the assessments as appropriate. The possible locations of these above-ground structures, including the CSO drop shaft, are defined by the zones on the Site works parameter plan (see separate volume of figures – Section 1).

3.2.7 All other features on the Proposed landscape plan are illustrative only and have not been assessed. The landscaping proposals for approval for this site are provided in the site-specific design principles for this site (Design Principles report Section 4.20) (as summarised above).

Code of Construction Practice

3.2.8 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.

3.2.9 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 Greenwich Pumping Station 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. 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.

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

3.3.3 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

3.3.4 Construction at the Greenwich Pumping Station site is assumed to begin in 2016 (Site Year 1) and would be completed during 2021 (Site Year 6). The infrastructure at the site would only become operational in 2023 when the Thames Tideway Tunnel project as a whole becomes operational.

3.3.5 Construction at Greenwich Pumping Station is anticipated to take approximately five and a half years and would involve the following phases (with some overlaps):

a. Site Year 1 – Site setup (approximately eight months)

b. Site Years 1 to 2 – CSO drop shaft construction (approximately 12 months)

c. Site Years 2 to 4 - Tunnelling (approximately 20 months)

d. Site Year 4 – Secondary lining (approximately eight months)

e. Site Years 4 to 5 – Construction of other structures (approximately 18 months)

f. Site Years 5 to 6 – Completion of works and site restoration (approximately eight months).

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

3.3.7 Extended working hours are 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 four months, and once a month during other major concrete pours.

3.3.8 It has also been assumed that continuous hours would be required for below ground and tunnelling works for a total duration of approximately 20 months, and during secondary lining for a duration of approximately eight months. However, it is noted that there would be periods of activity within these phases where continuous 24 hour working would not be required, including TBM assembly, maintenance and dismantling.

3.3.9 The exact timing of any extended hours of working would be consulted on, and notified to the RB of Greenwich. During these periods only those activities directly connected with the task would be permitted within the varied hours.

Typical construction activities

3.3.10 Vol 24 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 24 Table 3.3.1 Greenwich Pumping Station − construction phase plans

Plan title	Activities	Status	Location
Construction phases – phase 1	Site setup and drop shaft construction	Illustrative	Vol 24 Greenwich Pumping Station figures – Section 1
Construction phases – phase 2	Tunnelling	Illustrative	Vol 24 Greenwich Pumping Station figures – Section 1
Construction phases – phase 3	Construction of other structures	Illustrative	Vol 24 Greenwich Pumping Station figures – Section 1

3.3.11 The construction work at Greenwich Pumping Station would encompass much of the existing Thames Water site, the disused East Beam Engine House and the northern area of the main site. The space below the existing coal sheds would be used for construction activities eg, parking, storage of materials and potentially office and welfare. In addition the site includes the Phoenix Wharf site, which sits to the north of the elevated railway line, would also be used to house construction facilities.

3.3.12 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.

3.3.13 The following physical construction works are described:

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

Site setup

3.3.14 Tree clearance and pruning would be required for on-site trees and also trees at the entrance to the site from Norman Road. The extent of demolition and site clearance works are shown on the Demolition and site clearance plan (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.

3.3.15 Prior to any works commencing the site boundary would be established and secured. The boundary would be built to the heights specified in the *CoCP* Part B Greenwich Pumping Station Section 4. The existing access gates off Norman Road would be upgraded, and a second, new, entrance off Norman Road into the Thames Water site constructed. Welfare and office facilities would also be set up.

3.3.16 A light traffic access route and traffic management measures would be set up beneath the railway arches to the Phoenix Wharf section of the site. The main access to the Phoenix Wharf section of the site would be via their existing entrances off Norman Road (further details provided below).

3.3.17 A new substation would be required on-site to supply power for the Greenwich connection tunnel drive from the site.

3.3.18 Utility diversion works on-site would be required to facilitate subsequent drop shaft and interception works.

3.3.19 Any decontamination works required within the existing pumping station site would be undertaken.

Shaft construction

3.3.20 Once the site has been prepared as described above, plant and material storage areas, an excavated material handling area and delivery vehicle turning area would be set up on site. Major plant required for the diaphragm wall works include cranes, diaphragm wall rigs, bentonite silos, separation plant, water tanks, mixing pans, compressors, air receivers, excavators and dumpers.

3.3.21 The CSO drop shaft would be constructed by diaphragm wall construction techniques. The first stage in the construction of each panel of diaphragm wall would be the excavation and forming 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.

3.3.22 This process would be repeated for each diaphragm wall panel in order to create 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.

3.3.23 The size of the diaphragm wall panels would require an extended working day to enable the concrete pour to be completed within a day.

3.3.24 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 and base would also be required to reduce the inflow of water. Dewatering would need to be undertaken as described below.

3.3.25 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. Excavated material would be put into skips within the drop shaft working area and hoisted by crawler crane from the drop shaft and deposited in a suitable storage area. After any required treatment, the material would be loaded onto a lorry for transport off site. Once the excavation is complete, a steel reinforced concrete base slab would be formed at the base of the drop shaft.

3.3.26 It is anticipated that dewatering would be required. Dewatering wells would be drilled from within the drop shaft (a process known as 'internal dewatering') and groundwater extracted via pumps. These pumps would be operational during drop shaft excavation. For the purpose of this assessment it has been assumed that the pumps would be maintained to ease the launch of the TBM en route to Chambers Wharf via Deptford Church Street and Earl Pumping Station. It is assumed that extracted groundwater would be discharged into Deptford Creek after being treated through a settlement system. Extracted water would be sampled on a regular basis to check water quality.

3.3.27 It is anticipated that ground treatment would be required within the Chalk and fissure grouting to the chalk immediately below the toe of the wall may also be required. In addition, ground treated blocks would be constructed either side of the drop shaft to facilitate TBM break out.

Tunnel construction

3.3.28 A connection tunnel approximately 4.6km long with an internal diameter of approximately 5.0m would be driven west from Greenwich Pumping Station to the Chambers Wharf site. On completion of the drop shaft construction described above, the worksite layout would be reconfigured to support the tunnelling works. This reconfigured layout would include:

a. slurry processing plant

b. excavated material storage areas including conveyors

c. tunnel lining storage areas including gantry cranes (which would be used to lower the sections into the drop shaft)

d. a noise enclosure over the drop shaft and gantry crane area to reduce potential noise effects (erected after TBM assembly)

e. materials laydown areas including slurry/water pipes, ventilation, tunnel railway track, power cable drums and TBM consumables

f. workshops/stores

g. grout batching plant.

3.3.29 The TBM sections would be delivered to site by road and assembled within the drop shaft serviced by large mobile or crawler cranes.

3.3.30 Tunnel portals would be formed in the drop shaft lining. The portals would consist of cast in-situ reinforced concrete. After TBM assembly but prior to the start of tunnelling works, the enclosure would be installed over the drop shaft area to mitigate for potential noise effects.

3.3.31 Once launched the TBM would cut the ground by rotating the cutter head whilst hydraulic shove rams would propel it forward. Precast concrete segmental tunnel linings would be installed as the TBM progresses. The excavated chalk would be transported back along the newly formed tunnel in slurry form through temporary pipework. The slurry would be pumped to the slurry processing plant on the surface where the solids would be separated and the excavated material transported off site. The TBM would move forward and a temporary railway built behind it within the tunnel as the TBM proceeds to bring material to the TBM including precast concrete segments. The slurry processing plant would consist of screens, centrifuges and hydro-cyclones and filter-presses together with attendant storage and treatment tanks. Lime dosing of the processed chalk has been assumed for this assessment although it could be alternate materials. At the end of the process a solid ‘cake’ would be formed and loaded on to lorries for transport to disposal site. The cleaned slurry would be re-circulated back to the advancing TBM.

Secondary lining of tunnel and shaft

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

3.3.33 It has been assumed that on completion of the tunnelling phase, a batching plant would be mobilised to site. The plant would supply the secondary lining of the Greenwich connection tunnel. Concrete would be batched on the surface and pumped or skipped to the connection tunnel. The underground railway would be used to transport the concrete and reinforcement to the area of the pour. The tunnel enclosure installed over the drop shaft and gantry crane area during tunnelling would remain in-situ during secondary lining.

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

3.3.35 It is assumed that the lining of the drop shaft would be made of reinforced concrete placed inside the drop shaft’s primary support. The steel reinforcement would be assembled in sections and a shutter would be used to cast the concrete against. The shutter would be assembled at the bottom of the drop shaft and sections of reinforcement installed and lining cast progressively up the drop shaft. At ground level an external shutter would be added to allow construction of the drop shaft to continue above ground level to the proposed roof slab level.

3.3.36 Any reinforced concrete structures internal to the drop shaft and the roof slab would be constructed in a similar manner progressively from the drop shaft bottom. In some cases precast concrete members may be used.

Construction of other structures

3.3.37 An interception chamber, connection culvert and valve chamber would be constructed to intercept the sewers running into the existing pumping station and connect them to the drop shaft. In addition, air management structures comprising a louvre chamber for ventilation control and an underground duct would be constructed on the site. Air management equipment and an electrical and control kiosk would be located within the existing east Beam Engine House.

3.3.38 Sheet pile walls would be used to provide ground support within which the underground chambers would be constructed. Walls would be constructed to a depth to minimise water ingress into the excavation, but small pumps would be utilised to manage any ground water that does seep through.

3.3.39 The pumps would discharge to the sewer or Deptford Creek after being treated through a settlement system.

3.3.40 The walls, bases and roofs of the chambers and shallow foundations for above-ground structures would be formed by *in situ* concrete techniques. Ready mixed concrete would be delivered to site from an external supplier and either pumped or skipped to the chamber. The piled walls would be extended to the drop shaft to allow the connecting culvert to be constructed in a similar manner to the chambers.

3.3.41 For the above-ground structures, the components would be delivered by road and assembled on site using suitable lifting equipment.

Completion of works and site restoration

3.3.42 On completion of the construction works, the permanent works area would be finished in accordance with the landscaping requirements (seen Section 3.2).

Excavated materials and waste

3.3.43 The construction activities described above and in particular the construction of the Greenwich connection tunnel would generate a large volume of excavated material which would require removal. This is estimated at 320,000 tonnes, the main elements of which would comprise approximately 290,000 tonnes of chalk, 10,000 mixed materials from the diaphragm wall construction, 9,000 tonnes of Made ground, 6,000 tonnes of Thanet sands, 3,000 of Lambeth sands and 1,000 tonnes of material from site strip.

3.3.44 In addition, it is estimated that approximately 1,700 tonnes of construction waste would be generated including 1,000 tonnes of concrete, 200 tonnes of grout, 50 tonnes of concrete rings, 20 tonnes of imported fill and 400 tonnes of other construction material.

3.3.45 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

3.3.46 For the purposes of this assessment it has been assumed that all excavated material would be removed from site by road. In this 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'.

3.3.47 The highest lorry movements (peak vehicle movements) at the site would occur during connection tunnel construction when material would be removed from the site by road. The daily vehicle movements at this time, averaged over a one month period, would be 77 heavy goods vehicle (HGV) lorries, equivalent to 154 movements per day. It is estimated that total vehicle numbers for this site would be approximately 32,300 HGV lorries, equivalent to 64,600 movements over the construction period.

3.3.48 The site would be serviced via six access points, one off Greenwich High Road (light traffic only) and five off Norman Road. The site would operate a two way traffic system for the Greenwich High Road access point and one of the access points at Norman Road.

3.3.49 The main access/egress to the site is proposed to be onto Norman Road. Construction lorries would take the route of minimum impact to the Transport for London Route Network (TLRN). It is envisaged that lorries would route from the A2 – Blackheath Road corridor, although, the A200 - Evelyn Street/Creek Road corridor would also be considered. Locally vehicles would be routed via the A206 – Greenwich High Road or B208 - Norman Road respectively.

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

3.3.51 A *Draft Project Framework Travel Plan*, which accompanies the application, has been produced setting out the requirements and guidelines for the site-specific *Travel pla*ns 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 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 and Greenwich connection tunnel to the main tunnel for treatment at Beckton Sewage Treatment Works. The number of CSO discharges would be reduced by 47 spill events to approximately four times per typical year totalling a volume of 573,000m^3 per year.

Operational structures

3.4.5 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).

3.4.6 The heights of the access and ventilation structure, drop shaft and the Interception and valve chambers 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.

3.4.7 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. The approach that has been adopted in this regard is explained within each topic assessment section, where necessary.

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

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

Shaft

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

Chambers and culverts

3.4.11 The interception chamber, culvert and valve chamber would be below ground. There would be covers on top of the chambers to allow for access and inspection.

Air management structures

3.4.12 An active ventilation plant would be housed in the disused East Beam Engine House on the east side of the Greenwich Pumping Station building. The heights and locations of above-ground air management structures are defined in Section 3.2. The air management structure would contain electric fans drawing air through carbon odour control units with a combined capacity to treat an air flow rate of $4m^3/s$. Underground ducts would convey air from the drop shaft to treatment.

3.4.13 Treated air would be released at height through existing openings in the southeast side of the building. It is assumed that the pressure relief ventilation structure would be located on the drop shaft roof.

Electrical and control kiosk

3.4.14 It is assumed that electrical and control panels would be housed in the existing East Beam Engine House and pumping station buildings.

Permanent restoration and landscaping

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

3.4.16 Most of the operational structures at the site would be below ground, although the drop shaft and valve chamber need to be finished to approximately 1.5m above-ground level due to hydraulic requirements.

3.4.17 It is assumed that the areas around the drop shaft and the interception chamber would be finished with hardstanding to allow crane access to the covers on top of them.

3.4.18 The corner of the Thames Water site northwest of the DLR viaduct, currently unpaved hardstanding, would be soft landscaped. Other areas within the pumping station would be either returned to hardstanding to provide continued operational access within the pumping station, or to landscaping, similar to their existing status. The areas not required for operational access would be planted with wild flower and grassland.

3.4.19 The primary access to the Thames Water Greenwich Pumping Station site would continue to be through the main site gates onto Greenwich High Road. An additional site access to the operational pumping station would be retained from Norman Road.

Typical maintenance regime

3.4.20 A light commercial vehicle would undertake three to six monthly maintenance works, likely combined with other maintenance on the pumping station site. This would be carried out during normal working hours and would take approximately half a day. There would be no new aerial lighting provided at this site. Additionally, once every ten years, more significant maintenance work would be carried out. 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 projects included in the assessment. A schedule is provided in Vol 24 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, with construction preceding that of the Thames Tideway Tunnel site, and cumulative with construction or operation occurring 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 Greenwich Pumping Station are listed below. A map showing their location is included in Vol 24 Figure 3.5.1 (see separate volume of figures).

a. Block E, 43-81 Greenwich High Road

b. 83-87 Greenwich High Road

c. Greenwich Industrial Estate (land bounded by Norman Road, Greenwich High Road and Waller Way)

d. Hilton's Wharf, 30-52 Norman Road, Greenwich

e. Creekside Village East (Thanet Wharf), Copperas Street

f. Site of old Seagar Distillery and Norfolk House, 4-12 Deptford Bridge

g. Greenwich Reach East

h. Bardsley Lane (land at Creek Road/Bardsley Lane)

i. Heathside and Lethbridge Estate

j. Land at Stockwell Street and John Humphries House

k. Land opposite North Greenwich Pier, Greenwich Peninsula.

3.6 On-site alternatives

3.6.1 Project-wide and site selection alternatives are addressed in Volume 1 Section 3. This section describes on-site alternatives that have been considered and provides the main reasons why these alternatives (to the proposed approach) have not been adopted.

3.6.2 Vol 24 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 24 Table 3.6.1 Greenwich Pumping Station − on-site alternatives

Item	Alternatives considered	Reasons not progressed
Coal Sheds	Temporary of dismantling of Grade II listed Coal Sheds to enable space occupied by the sheds to be used for construction works. Proposal for sheds to be re-erected following construction.	• English Heritage preference for Coal Sheds to not be dismantled. • Proposed option to retain and use space beneath Coal Sheds reduces risk of damage to the listed structures.
Grade II Listed Beam Engine House	Alternative includes no works proposed within Beam Engine House. Proposal for construction of a building to house air management plant and equipment. Also includes construction of structure to house electrical and control kiosk.	• Preference to bring Grade II Listed Beam Engine House back into use. • Proposals to incorporate ventilation and electrical panels into the Beam Engine House removes requirement for construction of additional structures.

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.24**

Volume 24: Greenwich Pumping Station site assessment

Section 4: Air quality and odour

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

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January 2013

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

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Thames Tideway Tunnel

Environmental Statement

Volume 24: Greenwich Pumping Station 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 Greenwich Pumping Station 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. emissions from construction plant (air quality)

c. construction-generated dust (air quality)

d. 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 the Greenwich Pumping Station site comprises three separate components: effects on local air quality from construction road traffic; effects on local air quality from construction plant; and effects from construction dust. The effects on local air quality from construction road traffic 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 Volume 2 Environmental assessment methodology 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 24 Greenwich Pumping Station figures). Appendices supporting this site assessment are contained in Volume 24 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 Greenwich Pumping Station site would occur during tunnel driving (Site Year 3 of construction). The average daily number of vehicle movements during the peak month would be approximately 154 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.

Construction plant

4.2.6 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.

4.2.7 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.

4.2.8 Typical construction plant which would be used at the Greenwich Pumping Station site in the peak construction year and associated emissions data are presented in Vol 24 Appendix B.3.

Construction dust

4.2.9 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).

4.2.10 At the Greenwich Pumping Station site there would be approximately 1,600m^3 of demolition material generated while the amount of material moved during the earthworks would be approximately 320,000 tonnes. The volume of building material used during construction would be approximately 29,800m^3.

Code of Construction Practice

4.2.11 Appropriate dust and emission control measures are included in the *Code of Construction Practice* (*CoCP*)[ii] Part A (Section 7) in accordance with the

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

London Councils Best Practice Guidance (Greater London Authority and London Councils, 2006)[1]. Measures incorporated into the *CoCP* Part A (Section 7) 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 Greenwich Pumping Station site.

4.2.12 The effective implementation of the *CoCP* Part A (Section 7) measures is assumed within the assessment.

Operation

4.2.13 Air management plant and equipment would be housed in the disused beam engine building on the east side of the Greenwich Pumping Station building. The building would house fans drawing air through two air treatment units giving a total treatment capacity of $8m^3/s$ of air from the tunnel. The air having passed through the air treatment units would be released from the existing ventilation columns in the beam engine building. The maximum air release rate during a typical year is expected to be $8m^3/s$.

4.2.14 Air would be released from the ventilation column for 1,050 hours in a typical year, all of which would have passed through the air treatment units. For the remaining hours, no air would be released.

4.2.15 This information on the ventilation structure has been used in the dispersion model to assess odour dispersion at the site.

Environmental design measures

4.2.16 An active ventilation and air treatment plant would be included as part of the design and construction. The air treatment units would remove odours emanating from the tunnel. Full details of the Thames Tideway Tunnel project ventilation system can be found in the *Air Management Plan*.

4.3 Assessment methodology

Engagement

4.3.1 Vol 2 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 24 Table 4.3.1).

Vol 24 Table 4.3.1 Air quality and odour – stakeholder engagement

Organisation	Comment	Response
RB of Greenwich, April 2011	Agree monitoring locations with the RB of Greenwich	Locations agreed with RB of Greenwich Environmental Health

[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).

Organisation	Comment	Response
		Officer.
RB of Greenwich, July 2012	Odour complaints in the area should be considered	No odour complaints around Greenwich Pumping Station site - confirmed by RB of Greenwich Environmental Health Officer.

Baseline

4.3.2 The baseline methodology follows the methodology described in Vol 2 Section 4. There are no site specific variations for identifying baseline conditions for this site.

Construction

4.3.3 The assessment methodology for the construction phase follows that described in Vol 2 Section 4. 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 Greenwich Pumping Station site. There are no other Thames Tideway Tunnel project sites which could elevate construction dust nuisance effects within the assessment area (see para. 4.3.5 below). With regard to local air quality, the effect of all relevant traffic associated with Thames Tideway Tunnel project sites using the highway network in the vicinity of the site is taken into account in the assessment as traffic data used for the assessment includes traffic associated with all Thames Tideway Tunnel project 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 Greenwich Pumping Station site. This assessment area has been used for the assessment of road transport, construction plant and construction dust and has been selected on the basis of professional judgement to ensure that the effects of the Greenwich Pumping Station site are fully assessed. A distance of 200m is generally considered sufficient (Highways Agency, 2007)[2] to ensure that any significant effects are considered. The selected assessment area exceeds this considerably.

Construction assessment year

4.3.6 The peak construction year in terms of construction traffic movements (Site Year 3 of construction) has been used as the year of assessment for construction effects (construction road transport, construction plant and construction dust) in which the development case (with the Thames Tideway Tunnel project) has been assessed against the base case (without the Thames Tideway Tunnel project) to identify likely significant effects for 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 24 Appendix N), there are six other new developments (43-81 Greenwich High Road (Block E change of use), 83-87 Greenwich High Road, Greenwich Industrial Estate, Hilton's Wharf, Creekside Village East and development on the site of the old Seagar Distillery) identified within the air quality assessment area, all of which are relevant to the air quality assessment being sensitive properties in close proximity to the site. These developments are therefore considered as receptors in the air quality assessment. Trips associated with the other developments are taken into account in the traffic data used for the air quality assessment.

4.3.9 Of these six developments identified, the Creekside Village East would be under construction in the peak construction year at the Greenwich Pumping Station site. There is therefore the potential for cumulative effects which are considered in Section 4.7.

Operation

4.3.10 The odour assessment methodology for the operational phase follows that described in Vol 2 Section 4. 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 construction at the Greenwich Pumping Station site. There are no other Thames Tideway Tunnel project sites which could give rise to additional effects on odour within the assessment area (see para. 4.3.12 below) and therefore no other Thames Tideway Tunnel project sites are considered in this assessment.

Operational assessment area

4.3.12 Odour dispersion modelling has been carried out over an area of 700m by 600m centred on the Greenwich Pumping Station 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 Vol 2 Section 4) applies equally to all operational years. Therefore no specific year of operation has been assessed.

Other developments

4.3.14 As indicated in the site development schedule (see Vol 24 Appendix N), there are six other new developments 43-81 Greenwich High Road (Block E change of use), 83-87 Greenwich High Road, Greenwich Industrial Estate, Hilton's Wharf, Creekside Village East and development on the site of the old Seagar Distillery) identified within the assessment area, all of which are relevant to the odour assessment being sensitive properties in close proximity to the site. These developments are therefore considered as receptors in the odour assessment. The proposed buildings at 43-81 Greenwich High Road, 83-87 Greenwich High Road, Greenwich Industrial Estate and Hilton's Wharf have been included in the modelling as these buildings are close to the Greenwich Pumping Station site and may affect dispersion. Due to the nature of the developments there are no cumulative operational odour effects to assess.

Assumptions and limitations

Assumptions

4.3.15 The general assumptions associated with this assessment are presented in Vol 2 Section 4.

Construction

4.3.16 The site specific assumptions in terms of model inputs for the local air quality dispersion modelling are set out in Vol 24 Appendix B.1. There are no assumptions specific to the assessment of this site.

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. 4.2.13 - 4.2.16.

4.3.18 Odour dispersion modelling for the development case 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 only been a few recorded 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 (Michigan Environmental Science Board, 2000)[3].

4.3.19 The ventilation structures were located for the dispersion modelling in a position that was expected to result in the highest concentrations at buildings and so represent a worst-case scenario. This location would be within the area marked on the Site parameter plan (see separate volume of figures - Section 1). It is therefore likely that the actual concentrations would be lower than those reported in this assessment.

Limitations

4.3.20 The general limitations associated with this assessment are presented in Vol 2 Section 4.

Construction

4.3.21 As there is no sufficient traffic data for the roads adjacent to the PM_{10} monitoring sites located within the vicinity of the Greenwich Pumping Station site, it has not been possible to verify PM_{10} modelling results using the monitoring from these sites. The adjustment factor derived for nitrogen oxides (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.

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

4.4.4 There are two continuous monitoring stations and six NO_2 diffusion tube sites which collect data pertinent to the Greenwich Pumping Station site and associated construction traffic routes operated by RB of Greenwich and London Borough (LB) of Lewisham. The location of these is shown in Vol 24 Figure 4.4.1 (see separate volume of figures). Monitoring data for this site for the period 2007-2011 are contained in Vol 24 Table 4.4.1 (NO_2 concentrations) and Vol 24 Table 4.4.2 (PM_{10} concentrations).

Vol 24 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											
Blackheath (GR7)	Roadside	**48**	**43**	**43**	**46**	**49**	1	0	0	0	5
Lewisham New Cross (LW2)	Roadside	**51**	**59**	**64**	**64**	**47**	0	0	9	5	0
Diffusion tube monitoring sites											
Blackheath Hill (GW33)	Roadside	**54**	**50**	**60**	**63**	**71**	NM				
Greenwich Church Street (GW42)	Roadside	**50**	**53**	**58**	**56**	**63**	NM				
Creek Road / McMillan St (GW43)	Roadside	**57**	**41**	**59**	**58**	**62**	NM				
Greenwich South Street (GW48)	Roadside	**43**	38	**47**	**49**	**57**	NM				
Maidenstone Hill (GW58)	Roadside	**46**	**52**	**47**	**49**	**52**	NM				
Grinling Gibbons Primary School (SCH018)	Background	31	35	NM	NM	NM	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 24 Figure 4.4.1.

Vol 24 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
Blackheath (GR7)	Roadside	32	28	24*	IDC	27	**41**	20	12* (40.0)	IDC	28
Lewisham New Cross (LW2)	Roadside	26	25	25	25	30	19	6	12	16	15

*Note: * Data capture for 2009 only 76%, figure in brackets for the number of exceedances is 90th percentile. IDC – Insufficient data capture (<75%). Emboldened figures indicate an exceedance of the objective / limit value which is 40µg/m^3 for the annual mean and 50µg/m^3 for the daily mean which can be exceeded 35 times per year. Codes in brackets represent monitoring site identifiers used in Vol 24 Figure 4.4.1 (see separate volume of figures).*

4.4.5 The NO_2 monitoring in 2011 at all the roadside sites indicates exceedances of the annual mean NO_2 objective / limit value (40µg/m^3). The objective / limit value is however met at the background site at Grinling Gibbons Primary School. The other four years also indicate exceedances of the annual mean objective at all roadside sites, except the Greenwich South Street site in 2010. The hourly objective was met for all five years at the Blackheath and New Cross roadside sites.

4.4.6 The PM_{10} monitoring at the roadside locations indicates that the annual mean objective / limit value was met in 2011 and in the previous four years where there is a valid monitoring dataset. The daily mean air quality objective for PM_{10} was exceeded in 2011 at the Blackheath roadside site, but achieved in all other years and achieved at the Lewisham New Cross in all five years.

4.4.7 As a result of previous exceedances of air quality objectives, the RB of Greenwich has declared the whole Borough an AQMA for both 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 project to monitor NO_2 concentrations in the vicinity of the Greenwich Pumping Station site. This monitoring comprises ten diffusion tubes based at the locations identified in Vol 24 Table 4.4.3, which shows a 2010 annual mean concentration (baseline year), which has been calculated from the measurements made between April 2011 and April 2012 at each of the sites. To calculate the 2010 annual mean NO_2 concentrations, the 2011/12 measurements are adjusted for bias using the co-located diffusion tubes and are then seasonally adjusted. Annual mean NO_2 concentrations, for the period covered by the diffusion tubes, and for the year 2010 have been collated from four nearby background continuous monitoring sites measuring NO_2 and with data capture rates greater than 90%. The average of the ratios between the period and annual means has been used to calculate the seasonal adjustment factor. To enable any bias to be corrected a triplicate site (comprising three diffusion tubes) was established at a continuous monitoring site in Putney (site PEFM4 – see Vol 7); for additional precision, a triplicate site was established at two of the monitoring sites (GPSM5 and DCSM1) near the Greenwich Pumping Station site; otherwise all the monitoring locations have single tubes.

Vol 24 Table 4.4.3 Air quality – additional monitoring locations

Monitoring site	Grid reference	Site type	2010 NO_2 annual mean (µg/m^3)
A206 Greenwich High Road (GPSM1)	537716, 177085	Kerbside	**65.8**
B208 Norman Road South (GPSM2)	537798, 177186	Roadside	**67.6**
B208 Norman Road North (GPSM3)	537844, 177512	Roadside	**57.0**

Monitoring site	Grid reference	Site type	2010 NO_2 annual mean ($\mu g/m^3$)
A200 Creek Road (GPSM4)	538025, 177712	Kerbside	**82.9**
A200 Creek Road (DCSM1)	537221, 177679	Roadside	**69.1**
A200 Creek Road (DCSM5)	537472, 177640	Roadside	**74.2**
Crossfield Street (DCSM6)	537259, 177419	Urban background	**42.9**
A2209 Deptford Church Street (DCSM7)	537393, 177268	Roadside	**57.8**
A2209 Deptford Church Street (DCSM8)	537389, 177024	Roadside	**67.3**
New Cross Road A2 (DCSM9)	537197, 176965	Kerbside	**80.0**

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

4.4.9 All ten 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 London.

4.4.10 This monitoring has been used in conjunction with existing RB of Greenwich monitoring to define the baseline situation and also to provide input to model verification[iii].

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[5]. Mapped background pollutant concentrations are available for each 1km by 1km grid square within every local authority's administrative area for the years 2008 to 2020. The background data relating to the Greenwich Pumping Station site are given in Vol 24 Table 4.4.4 for 2010 (baseline year).

Vol 24 Table 4.4.4 Air quality – 2010 background pollutant concentrations

Pollutant*	2010
NO_2 ($\mu g/m^3$)	37.3

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

Pollutant*	2010
PM_{10} (µg/m^3)	21.3

*Note: * Annual mean for 1km grid square centred on 537500, 177500.*

Odour

4.4.12 The RB of Greenwich has not received any odour complaints for the local area over recent years (RB of Greenwich, 2012) [6]. Complaints in the Thames Water database were reviewed within an area of 500m radius of the Pumping Station. Of the eleven identified complaints, four in the years 2006, 2007, 2009 and 2010, relate to odour from the general sewerage system. The remaining seven, in 2006 (two complaints), 2009 (two complaints), 2010 (two complaints) and 2011 (one complaint), relate to Greenwich Pumping Station.

4.4.13 Data gathering for the project included spot measurements of hydrogen sulphide (H_2S) made near the site. The highest concentrations, up to 37.9µg/m^3, were measured on 28 February 2012 during northerly wind conditions. These levels are typical of urban areas3 when a faint odour may be detectable on occasions (WHO, 2000)[7][iv]. The monitoring results are summarised in Vol 24 Table 4.4.5 and the monitoring locations shown in Vol 24 Figure 4.4.2 (see separate volume of figures).

Vol 24 Table 4.4.5 Odour – measured H_2S concentrations

Location	Grid reference	Date	Time	H_2S concentration (µg/m^3)
Crossfield Estate (GPSS1)	537527, 177244	28/08/11	07:46:21	0.0
		28/08/11	07:46:50	0.0
		30/10/11	09:13:36	0.0
		30/10/11	09:14:03	0.0
		01/12/11	11:21:25	31.1
		01/12/11	11:22:41	13.9
		20/02/12	11:19:19	10.9
		20/02/12	11:20:11	7.6
		28/02/12	16:39:14	35.8
		28/02/12	16:40:33	8.1
		18/05/12	16:03:15	7.2
		18/05/12	16:03:58	6.7
Creekside	537576,	28/08/11	07:34:32	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 ($\mu g/m^3$)
Visitor Centre (GPSS2)	177303	28/08/11	07:35:02	0.0
		30/10/11	09:04:53	0.0
		30/10/11	09:05:31	0.0
		01/12/11	11:08:45	28.4
		01/12/11	11:10:45	8.1
		20/02/12	11:06:22	8.3
		20/02/12	11:07:24	6.9
		28/02/12	16:29:01	7.5
		28/02/12	16:30:21	7.2
		18/05/12	15:53:44	7.9
		18/05/12	15:57:27	10.5
Bridge (GPSS3)	537632, 177312	28/08/11	07:31:54	0.0
		28/08/11	07:32:24	0.0
		30/10/11	09:03:22	5.5
		30/10/11	09:03:50	0.0
		01/12/11	11:03:31	9.5
		01/12/11	11:04:37	7.1
		20/02/12	11:02:53	8.0
		20/02/12	11:04:05	6.7
		28/02/12	16:26:11	9.6
		28/02/12	16:27:16	8.3
		18/05/12	15:44:36	6.0
		18/05/12	15:45:37	6.0
		18/05/12	15:52:28	10.3
Merry Nealler Place (Premier Inn) (GPSS4)	537774, 177147	28/08/11	07:40:11	0.0
		28/08/11	07:40:43	0.0
		30/10/11	09:09:31	5.9
		30/10/11	09:10:02	0.0
		01/12/11	11:13:27	10.0
		01/12/11	11:14:31	8.1
		20/02/12	11:10:51	9.5
		20/02/12	11:12:10	7.4

Location	Grid reference	Date	Time	H_2S concentration ($\mu g/m^3$)
		28/02/12	16:31:56	8.2
		28/02/12	16:33:17	11.0
		18/05/12	15:58:34	9.2
		18/05/12	16:02:12	28.1
Norman Road (GPSS5)	537764, 177293	28/08/11	07:25:43	6.0
		28/08/11	07:26:14	0.0
		30/10/11	09:01:52	4.8
		30/10/11	09:02:22	0.0
		01/12/11	10:56:18	9.7
		01/12/11	10:59:41	8.2
		20/02/12	10:58:54	6.9
		20/02/12	10:59:46	7.3
		28/02/12	16:22:23	37.9
		28/02/12	16:23:54	10.5
		18/05/12	15:41:33	9.6
		18/05/12	15:42:30	6.8
Meteorological conditions: 28/08/11 SW wind up to 2m/s, 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 W wind up to 2.8m/s, partially cloudy. 20/02/12 S and W wind up to 1.8m/s, partially cloudy. 28/02/12 N wind up to 1.4m/s, sunny. 18/05/12 winds in all directions, average speed 1.7m/s.				

Receptors

4.4.14 As set out in Section 4.1 and Vol 2 Section 4, the air quality assessment involves the selection of appropriate receptors, which are shown in Vol 24 Figure 4.4.3 (see separate volume of figures) and the table below (Vol 24 Table 4.4.6) for the Greenwich Pumping Station site. All of these receptors are relevant, albeit with different levels of sensitivity to each of the elements of the air quality assessment. The sensitivity of identified receptors has been determined using the criteria detailed in Vol 2 Section 4.

4.4.15 It is noted that Vol 24 Table 4.4.6 includes receptors associated with the new developments (43-81 Greenwich High Road (Block E), 83-87 Greenwich High Road, Greenwich Industrial Estate, Hilton's Wharf, Creekside Village East and development on the site of the old Seagar

Distillery, (see site development schedule in Vol 24 Appendix N) for consideration in the air quality and odour assessments.

Vol 24 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)	Construction dust (on-site demolition and construction processes)	Odour (ventilation stack)
Residential – 83-87 Greenwich High Road (GPSR5)*	Adjacent	High (exposure relevant to annual mean, daily mean and hourly mean standards)	Medium	High
Residential – Greenwich Industrial Estate (north) (GPSR14)*	14m east	High (exposure relevant to annual mean, daily mean and hourly mean standards)	Medium	High
Residential – 82 Greenwich High Road (GPSR4)	25m south	High (exposure relevant to annual mean, daily mean and hourly mean standards)	Medium	High
Residential / Commercial – Millers Public House (GPSR2)	40m south	High (exposure relevant to annual mean, daily mean and hourly mean standards)	Medium	High
Residential – Greenwich Industrial Estate (south) (GPSR8)*	45m east	High (exposure relevant to annual mean, daily mean and hourly mean standards)	Medium	High
Residential – Block D, 43-81 Greenwich High Road (GPSR12)	50m south	High (exposure relevant to annual mean, daily mean and hourly mean standards)	Medium	High
Residential – Creekside Village East (GPSR10)*	120m north	Not included as a receptor as the development is still under construction in Site Year 3.		High
Residential – Hilton's Wharf	195m northeast	High (exposure relevant to annual	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)	Construction dust (on-site demolition and construction processes)	Odour (ventilation stack)
(GPSR9)*		mean, daily mean and hourly mean standards)		
Residential – Old Seagar Distillery (GPSR13)*	255m southwest	High (exposure relevant to annual mean, daily mean and hourly mean standards)	Medium	High
Educational - Lewisham College (GPSR1)	220m south	High (exposure relevant to annual mean, daily mean and hourly mean standards)	Medium	High
Hotel – Block E, 43-81 Greenwich High Road (GPSR11)*	Adjacent	Medium (exposure relevant to daily mean and hourly mean standards).	Medium	High
Place of Worship - Devonshire Drive Baptist Church (GPSR3)	115m southeast	Medium (exposure relevant to daily mean and hourly mean standards).	Medium	Medium
Community - Greenwich West Community and Arts Centre (GPSR7)	95m northeast	Medium (exposure is relevant for the hourly mean standard only).	Medium	Medium
Commercial – Norman House (GPSR6)	15m east	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[8] to the London vehicle fleet between the current situation and Site Year 3 of construction. Euro standards define the acceptable exhaust emission limits for new vehicles sold in the European Union (EU). These standards are defined through a series of EU directives staging the progressive introduction of increasingly stringent standards over time. The uptake of newer vehicles with improved emission controls should lead to a reduction in NO_2 and PM_{10} concentrations over time. These changes in fleet composition and the emissions are covered in this assessment.

4.4.18 Other emissions sources should also reduce due to local and national policies. Therefore, the non-road sources of the background concentrations used in the modelling have been reduced in line with Defra guidance LAQM.TG(09) (Defra, 2009)[9]. Background pollutant concentrations for Site Year 3 of construction (peak construction year) used in the modelling are shown in Vol 24 Table 4.4.7.

4.4.19 The background NO_2 concentration has been derived from the 2010 annual mean measured at the background site at Grinling Gibbons Primary School (SCH018). The background PM_{10} concentration has been taken from the Defra mapped background data5 as there are no suitable PM_{10} monitors within the assessment area.

Vol 24 Table 4.4.7 Air quality – annual mean background pollutant concentrations

Pollutant	Baseline (2010)	Peak construction year (Site Year 3 of construction)
NO_2 ($\mu g/m^3$)*	35.3	26.5
PM_{10} ($\mu g/m^3$)**	21.1	19.2

** Taken from monitoring site Grinling Gibbons Primary School (SCH018). ** Annual mean for 1km grid square centred on 537500, 177500. Adjusted to ensure local A roads are not double counted.*

4.4.20 As indicated in para. 4.3.8, the base case in Site Year 3 of construction takes into account six proposed developments at 43-81 Greenwich High Road (Block E change of use), 83-87 Greenwich High Road, Greenwich Industrial Estate, Hilton's Wharf, Creekside Village East and the development on the Old Seagar Distillery site, including them as receptor locations in the air quality assessment. These are included in the receptor list provided in Vol 24 Table 4.4.6.

Operational base case

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

4.4.22 As indicated in para. 4.3.14, the base case for the odour assessment takes into account the proposed developments at 43-81 Greenwich High Road (Block E change of use), 83-87 Greenwich High Road, Greenwich Industrial Estate, Hilton's Wharf, Creekside Village East and the development on the Old Seagar Distillery site, including them as receptor locations in the odour assessment. These are included in the receptor list provided in Vol 24 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 and construction plant) have been assessed following the modelling methodology set out in Vol 2 Section 4. This involves predicting NO_2 and PM_{10} concentrations in the baseline year (2010), and in the peak construction year (Site Year 3 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 24 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 (e.g. 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 Greenwich Pumping Station site in line with the Defra guidance LAQM.TG(09)9. This checks the model performance against measured concentrations, using two local authority monitoring sites (GW43 and GW48 – see Vol 24 Table 4.4.1) and ten monitoring sites established for this assessment (GPSM1–GPSM4, DCSM1, DCSM5-DCSM9 – see Vol 24 Table 4.4.3). Further details regarding the verification process are included in Vol 24 Appendix B.1. The model adjustment factor derived from the verification process was applied to all model results (for both NO_2 and PM_{10}).

4.5.4 The model inputs for the local air quality assessment for the Greenwich Pumping Station site are also detailed in Vol 24 Appendix B.2 and B.3. 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 construction plant.

NO_2 concentrations

4.5.5 Predicted annual mean NO_2 concentrations for the modelled scenarios, are shown in Vol 24 Table 4.5.1Vol 24 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 24 Figure 4.5.1 to Vol 24 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 24 Figure 4.5.4 (see separate volume of figures).

4.5.6 The modelled concentrations in Vol 24 Table 4.5.1 show that annual mean NO_2 levels are predicted to decrease between 2010 and the peak construction year with or without the Thames Tideway Tunnel project. This decrease is due to predicted reductions in background concentrations and improved vehicle engine technology. The results for the development case show increases over the base case at all modelled receptors due to the construction works at the Greenwich Pumping Station site.

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

Vol 24 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					
83-87 Greenwich High Road residential (GPSR5)*	**54.0**	**40.5**	**41.9**	1.4	Small
82 Greenwich High Road	**57.7**	**43.7**	**45.5**	1.9	Small

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		
residential (GPSR4)					
Millers Public House (GPSR2)	**53.1**	39.7	**41.0**	1.3	Small
Greenwich Industrial Estate (north) residential (GPSR14)*	**50.9**	38.4	**40.0**	1.6	Small
Greenwich Industrial Estate (south) residential (GPSR8)*	**57.0**	**43.6**	**44.1**	0.5	Small
Block D, 43-81 Greenwich High Road residential (GPSR12)	**47.4**	35.4	36.1	0.8	Small
Hilton's Wharf residential (GPSR9)*	**52.3**	39.3	39.9	0.6	Small
Old Seagar Distillery residential (GPSR13)*	**103.1**	**81.9**	**83.6**	1.7	Small
Lewisham College (GPSR1)	**106.2**	**84.8**	**86.2**	1.4	Small
Receptors where the annual mean objective / limit value does not apply					
Block E, 43-81 Greenwich High Road, hotel (GPSR11)*	**45.7**	34.1	34.9	0.8	Small
Devonshire Drive Baptist Church (GPSR3)	**49.0**	36.9	37.5	0.7	Small
Greenwich	**49.8**	37.6	38.1	0.5	Small

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		
West Community and Arts Centre (GPSR7)					
Norman House (GPSR6)	**55.8**	**42.5**	**43.8**	1.3	Small

*Note: Emboldened figures indicate an exceedance of the criteria which is 40µg/m^3 for the annual mean. * Denotes receptor that is altered or constructed after the baseline year. Changes 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 Greenwich Pumping Station site is 1.9µg/m^3 which is predicted at the residential property at 82 Greenwich High Road (GPSR4). This increase is described as small magnitude according to the criteria detailed in Vol 2 Section 4.

4.5.9 The significance of the effect at the proposed residential properties at 83-87 Greenwich High Road (GPSR5), Block E of 43-81 Greenwich High Road (GPSR12), 82 Greenwich High Road (GPSR4), Millers Public House (GPSR2), Greenwich Industrial Estate (north) (GPSR14), Greenwich Industrial Estate (south) (GPSR8), Hilton's Wharf (GPSR9), old Seagar Distillery site (GPSR13) and Lewisham College (GPSR1), which have a high sensitivity to local air quality, is **minor adverse**. The significance of the effects at all other receptors would be **negligible**.

PM_{10} concentrations

4.5.10 Predicted annual mean PM_{10} concentrations for the modelled scenarios are shown in Vol 24 Table 4.5.2. This table details the forecast PM_{10} concentrations at specific sensitive receptors. Additionally, contour plots are provided (Vol 24 Figure 4.5.5 to Vol 24 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 24 Figure 4.5.8 (see separate volume of figures).

4.5.11 The modelled concentrations in Vol 24 Table 4.5.2 show that annual mean concentrations of PM_{10} are predicted to achieve the annual mean objective / limit value (40µg/m^3) and decrease between 2010 and the peak construction year with or without the Thames Tideway Tunnel project. This decrease is due to predicted reductions in background concentrations and improved vehicle engine technology. The predicted results for the development case show increases over the base case at all but two modelled receptors due to construction activities at the Greenwich Pumping Station site.

Vol 24 Table 4.5.2 Air quality – predicted annual mean PM_{10} concentrations

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		
Receptors where the annual mean objective / limit value applies					
83-87 Greenwich High Road residential (GPSR5)*	24.3	21.7	21.8	0.1	Negligible
82 Greenwich High Road residential (GPSR4)	25.1	22.3	22.5	0.2	Negligible
Millers Public House (GPSR2)	24.1	21.6	21.7	0.1	Negligible
Greenwich Industrial Estate (north) residential (GPSR14)*	23.7	21.2	21.5	0.2	Negligible
Greenwich Industrial Estate (south) residential (GPSR8)*	24.8	21.9	22.0	0.1	Negligible
Block D, 43-81 Greenwich High Road residential (GPSR12)	23.1	20.7	20.8	0.0	Negligible
Hilton's Wharf residential (GPSR9)*	24.0	21.4	21.5	0.1	Negligible
Old Seagar Distillery residential (GPSR13)*	35.6	29.5	29.7	0.2	Negligible

Receptor	Predicted annual mean PM_{10} concentration ($\mu g/m^3$)			Change between base and dev cases ($\mu g/m^3$)	Magnitude of impact
	2010 baseline	Peak construction year base case	Peak construction year dev case		
Lewisham College (GPSR1)	36.4	29.8	30.0	0.1	Negligible
Receptors where the annual mean objective / limit value does not apply					
Block E, 43-81 Greenwich High Road, hotel (GPSR11)*	22.7	20.5	20.6	0.1	Negligible
Devonshire Drive Baptist Church (GPSR3)	23.4	21.0	21.0	0.1	Negligible
Greenwich West Community and Arts Centre (GPSR7)	23.6	21.1	21.1	0.0	Negligible
Norman House (GPSR6)	24.6	21.8	21.9	0.1	Negligible

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

4.5.12 The largest predicted increase in the annual mean concentration as a result of construction at the Greenwich Pumping Station site is $0.2\mu g/m^3$, predicted at the residential properties at 82 Greenwich High Road (GPSR4), at the proposed residential properties at Greenwich Industrial Estate (north) (GPSR14) and Old Seagar Distillery (GPSR13). This change is described as negligible according to the criteria detailed in Vol 2 Section 4.

4.5.13 As predicted PM_{10} concentrations are well below the annual mean PM_{10} standard, the significance of the effects is **negligible** at all receptors.

4.5.14 With regard to the daily mean PM_{10} concentrations, Vol 24 Table 4.5.3 shows the predicted number exceedances of the daily PM_{10} standard ($50\mu g/m^3$) for each modelled scenario. The objective / limit value allows no more than 35 exceedances in a year.

Vol 24 Table 4.5.3 Air quality – predicted number of exceedances of the daily PM_{10} standard

Receptor	Predicted number of exceedances of the daily PM_{10} standard			Change between base and dev cases (days)	Magnitude of impact
	2010 baseline	Peak construction year base case	Peak construction year dev case		
Receptors where the objective / limit value does apply					
83-87 Greenwich High Road residential (GPSR5)*	11	6	6	0	Negligible
82 Greenwich High Road residential (GPSR4)	13	7	7	0	Negligible
Millers Public House (GPSR2)	10	6	6	0	Negligible
Greenwich Industrial Estate (north) residential (GPSR14)*	9	5	5	0	Negligible
Greenwich Industrial Estate (south) residential (GPSR8)*	12	6	6	0	Negligible
Block D, 43-81 Greenwich High Road residential (GPSR12)	8	4	4	0	Negligible
Hilton's Wharf residential (GPSR9)*	10	5	5	0	Negligible
Old Seagar Distillery residential (GPSR13)*	**53**	26	26	1	Small
Lewisham College (GPSR1)	**57**	27	27	0	Negligible
Block E, 43-81 Greenwich High	8	4	4	0	Negligible

Receptor	Predicted number of exceedances of the daily PM_{10} standard			Change between base and dev cases (days)	Magnitude of impact
	2010 baseline	Peak construction year base case	Peak construction year dev case		
Road, hotel (GPSR11)*					
Devonshire Drive Baptist Church (GPSR3)	9	5	5	0	Negligible
Receptors where the objective / limit value does not apply					
Greenwich West Community and Arts Centre (GPSR7)	9	5	5	0	Negligible
Norman House (GPSR6)	12	6	6	0	Negligible

*Notes: Emboldened figures indicate an exceedance of the objective / limit value which is 50µg/m^3 not to be exceeded more than 35 days in a year. * Denotes receptor that is altered or constructed after the baseline year. Changes at each receptor have been rounded to the nearest whole number.*

4.5.15 The results in Vol 24 Table 4.5.3 show that the number of daily exceedances of PM_{10} is predicted to decrease between 2010 and the peak construction year with or without the Thames Tideway Tunnel project. This decrease is due to predicted reductions in background concentrations and improved vehicle engine technology. The predicted results for the development case show a maximum increase of one day per year with concentrations above 50µg/m^3 compared with the base case at the modelled receptors due to construction works at the Greenwich Pumping Station site.

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

Sensitivity test for programme delay

4.5.17 For the assessment of local air quality effects during construction, a delay to the Thames Tideway Tunnel project of approximately one year would not be likely to materially change the assessment findings reported above for the existing and proposed receptors. Based on the development schedule (Vol 24 Appendix N), it is possible that as a result of the one year delay, part of the Creekside Village East development may be complete and occupied. However, it is not expected that any new receptors would experience different effects to those receptors assessed above, rather it would be a case of the potential for some additional receptors to experience the same (or lesser due to their distance from the Greenwich Pumping Station site) effects to those that have already been identified.

Construction dust

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

4.5.19 Dust sensitive receptors have been identified in the vicinity of the Greenwich Pumping Station site in accordance with the criteria in Vol 2 Section 4, as described in Vol 24 Table 4.4.6. A summary of the approximate numbers of receptors in distance bands from the Greenwich Pumping Station site is listed in Vol 24 Table 4.5.4.

Vol 24 Table 4.5.4 Air quality – numbers of dust sensitive receptors

Buffer distance (m)	Number of receptors*	Receptor type
<20	10-100	Residential, hotel, commercial and offices
20-50	100-500	Residential and offices
50-100	100-500	Residential, offices, hotel, place of worship and community centre
100-350	100-500	Residential, hotel, offices, open space and college

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

4.5.20 In line with the Institute of Air Quality Management (IAQM) guidance (IAQM, 2012)[10], the site has been categorised using the criteria given in Vol 2 Section 4 to assess the likely impacts from demolition, earthworks, construction and trackout activities during construction and the likely effects of these activities on sensitive receptors close to the development.

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

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

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

4.5.24 There would be 50-100m of unpaved haul roads on site and the number of construction lorries per day would be greater than 100, so the trackout dust emission class is classified as ‘large’. The closest receptor is within

20m of the affected roads. The risk category from trackout is therefore assessed to be high risk.

4.5.25 The risk categories for the four activities are summarised in Vol 24 Table 4.5.5. This summary of these risks does not take into account the measures outlined in the *CoCP* Part A (Section 7).

Vol 24 Table 4.5.5 Air quality – summary of construction dust risks

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

Note: without CoCP (Section 7) measures

4.5.26 On this basis, the development at the Greenwich Pumping Station site is classified as a high risk site overall.

4.5.27 Although the receptor sensitivity (with respect to construction dust nuisance) is identified as medium for all receptors (as identified in Vol 24 Table 4.4.6), due to the duration of the works and the high PM_{10} background concentrations in the locality, the sensitivity of the area has been defined as 'high'.

4.5.28 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 mitigation. When the measures outlined in the *CoCP* Part A (Section 7) are applied, the significance of the effect would be reduced to **minor adverse** (in accordance with IAQM guidance). This significance relates to receptors within 20m of the construction area. For receptors at distances greater than 20m from the construction are, the significance of the effect is **negligible**. The significance of the effect for each receptor is summarised in Vol 24 Table 4.5.6.

Vol 24 Table 4.5.6 Air quality – significance of construction dust impacts

Receptor	Significance of impact
83-87 Greenwich High Road residential (GPSR5)*	Minor adverse
82 Greenwich High Road residential (GPSR4)	Negligible
Millers Public House (GPSR2)	Negligible
Greenwich Industrial Estate (north) residential (GPSR14)*	Minor adverse
Greenwich Industrial Estate (south)	Negligible

Receptor	Significance of impact
residential (GPSR8)*	
Block D, 43-81 Greenwich High Road residential (GPSR12)	Negligible
Hilton's Wharf residential (GPSR9)*	Negligible
Old Seagar Distillery residential (GPSR13)*	Negligible
Lewisham College (GPSR1)	Negligible
Block E, 43-81 Greenwich High Road (north), hotel (GPSR11)*	Minor adverse
Devonshire Drive Baptist Church (GPSR3)	Negligible
Greenwich West Community and Arts Centre (GPSR7)	Negligible
Norman House (GPSR6)	Minor adverse

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

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 Section 4. Vol 24 Table 4.6.1 shows the predicted maximum ground level odour concentrations at the Greenwich Pumping Station site. These are the highest concentrations that could occur at the worst affected ground level receptor 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 Vol 2 Section 4. Vol 24 Table 4.6.2 gives similar results for the predicted impacts at the worst affected buildings, where concentrations at ground level and at various heights have been considered.

Vol 24 Table 4.6.1 Odour – impacts and magnitude at ground level operation

Year	Maximum at ground level locations*		Impact magnitude and justification
Typical	98th percentile (ou_E/m^3)	0.1	Negligible 98th percentile concentration is less than $1ou_E/m^3$
	No. of hours > $1.5ou_E/m^3$	2	

** Beyond site boundary*

Vol 24 Table 4.6.2 Odour – impacts and magnitude at buildings operation

Year	Maximum at buildings*		Impact magnitude and justification
Typical	98th percentile (ou_E/m^3)	0.1	Negligible 98th percentile concentration is less than $1ou_E/m^3$
	No. of hours > $1.5ou_E/m^3$	1	

** Beyond site boundary*

4.6.2 In the two tables above, the 98th percentile is shown as less than $1.5ou_E/m^3$. The maximum 98th percentile concentration beyond the site boundary was predicted to be $0.1ou_E/m^3$, approximately 40m to the northeast of the ventilation column in Norman Road and at Norman House, which is well within odour benchmark set by the EA at $1.5ou_E/m^3$. This means that the odour benchmark would be achieved at all locations. This represents an impact of negligible magnitude.

4.6.3 The highest frequency of odour beyond the site boundary is predicted to occur in Norman Road with two hours above $1.5ou_E/m^3$ in the typical year. The most frequent odour at buildings beyond the site boundary is predicted to be one hour in a year with concentrations above $1.5ou_E/m^3$, this could occur at buildings in Norman Road and Creekside Road. With a frequent use year (i.e, a more rainy year than average), the effects are likely to be similar to those in the typical use year.

4.6.4 With regard to the significance of effects at ground level and building locations, given that the predicted odour concentrations at all locations and at buildings 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, the Creekside Village East would be under construction during the peak construction year at the Greenwich Pumping Station site. It is expected that construction activities at the Creekside Village East site could elevate dust, NO_2 and PM_{10} concentrations near that site and could also have an effect near the Greenwich Pumping Station site. However, this effect is likely to be small and not affect the significance of the impact due to construction activities at the Greenwich Pumping Station site due to the distance between the two sites. Therefore the effects on air quality would remain as described in Section 4.5 above.

4.7.2 In the event that the programme for the Thames Tideway Tunnel is delayed by approximately one year, some of the Creekside Village East development may be built and occupied which would lead to a corresponding reduced level of cumulative activity. Cumulative effects would therefore be no greater than described above.

Operational effects

4.7.3 As described in Section 4.3, there would not be any cumulative operational effects. Therefore the effects on 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* Part A (Section 7) 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. 4.2.16), indicating that all effects would be negligible, no mitigation is required.

Monitoring

4.8.3 It is envisaged that an appropriate particulate monitoring regime would be agreed with the RB of Greenwich prior to commencement of construction at the Greenwich Pumping Station 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. Residual effects for all other receptors remain as 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 24 Table 4.10.1 Air quality – summary of construction assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Residential – 83-87 Greenwich High Road (GPSR5)*	Local air quality – effects from construction road traffic and plant emissions	Minor adverse	None	Minor adverse
	Effects from construction dust	Minor adverse	None	Minor adverse
Residential – Greenwich Industrial Estate (north) (GPSR14)*	Local air quality – effects from construction road traffic and plant emissions	Minor adverse	None	Minor adverse
	Effects from construction dust	Minor adverse	None	Minor adverse
Residential – 82 Greenwich High Road (GPSR4)	Local air quality – effects from construction road traffic and plant emissions	Minor adverse	None	Minor adverse
	Effects from construction dust	Negligible	None	Negligible
Residential / Commercial – Millers Public House (GPSR2)	Local air quality – effects from construction road traffic and plant emissions	Minor adverse	None	Minor adverse
	Effects from construction dust	Negligible	None	Negligible
Residential – Greenwich Industrial Estate (south) (GPSR8)*	Local air quality – effects from construction road traffic and plant emissions	Minor adverse	None	Minor adverse
	Effects from construction dust	Negligible	None	Negligible
Residential – Block D, 43-81 Greenwich High Road (GPSR12)	Local air quality – effects from construction road traffic and plant emissions	Minor adverse	None	Minor adverse
	Effects from construction dust	Negligible	None	Negligible

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Residential – Hilton's Wharf (GPSR9)*	Local air quality – effects from construction road traffic and plant emissions	Minor adverse	None	Minor adverse
	Effects from construction dust	Negligible	None	Negligible
Residential - Old Seagar Distillery (GPSR13)*	Local air quality – effects from construction road traffic and plant emissions	Minor adverse	None	Minor adverse
	Effects from construction dust	Negligible	None	Negligible
Educational - Lewisham College (GPSR1)	Local air quality – effects from construction road traffic and plant emissions	Minor adverse	None	Minor adverse
	Effects from construction dust	Negligible	None	Negligible
Hotel – Block E, 43-81 Greenwich High Road (north) (GPSR11)*	Local air quality – effects from construction road traffic and plant emissions	Negligible	None	Negligible
	Effects from construction dust	Minor adverse	None	Minor adverse
Place of Worship - Devonshire Drive Baptist Church (GPSR3)	Local air quality – effects from construction road traffic and plant emissions	Negligible	None	Negligible
	Effects from construction dust	Negligible	None	Negligible
Community - Greenwich West Community and Arts Centre (GPSR7)	Local air quality – effects from construction road traffic and plant emissions	Negligible	None	Negligible
	Effects from construction dust	Negligible	None	Negligible
Commercial – Norman House (GPSR6)	Local air quality – effects from construction road traffic and plant emissions	Negligible	None	Negligible
	Effects from construction dust	Minor adverse	None	Minor adverse

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

Vol 24 Table 4.10.2 Odour – summary of operational assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Residential – 83-87 Greenwich High Road (GPSR5)*	Odour	Negligible	None	Negligible
Residential – Greenwich Industrial Estate (north) (GPSR14)*		Negligible	None	Negligible
Residential – 82 Greenwich High Road (GPSR4)		Negligible	None	Negligible
Residential / Commercial – Millers Public House (GPSR2)		Negligible	None	Negligible
Residential – Greenwich Industrial Estate (south) (GPSR8)*		Negligible	None	Negligible
Residential – Block D, 43-81 Greenwich High Road (GPSR12)		Negligible	None	Negligible
Residential – Creekside Village East (GPSR10)*		Negligible	None	Negligible
Residential – Hilton’s Wharf (GPSR9)*		Negligible	None	Negligible
Residential – Old Seagar Distillery (GPSR13)*		Negligible	None	Negligible
Educational - Lewisham College (GPSR1)		Negligible	None	Negligible
Hotel – Block E, 43-81 Greenwich High Road (north) (GPSR11)*		Negligible	None	Negligible
Place of Worship - Devonshire Drive Baptist Church (GPSR3)		Negligible	None	Negligible
Community - Greenwich West Community and Arts Centre (GPSR7)		Negligible	None	Negligible
Commercial – Norman House (GPSR6)		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] 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).

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

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

[5] Defra, http://laqm.defra.gov.uk/review-and-assessment/tools/background-maps.html. Accessed June 2012.

[6] RB of Greenwich, *Personal Communication*, (July 2012).

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

[8] Defra, http://laqm.defra.gov.uk/review-and-assessment/tools/emissions.html#eft. Accessed June 2012.

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

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

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.24**

Volume 24: Greenwich Pumping Station site assessment

Section 5: Ecology - aquatic

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Thames Tideway Tunnel

Environmental Statement

Volume 24: Greenwich Pumping Station 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 Greenwich Pumping Station site.

5.1.2 Construction effects for aquatic ecology for this site have not been assessed. This is on the basis that there would be no in-river construction works associated with this site, which is adjacent to Deptford Creek. Therefore no significant construction effects are considered likely and for this reason only operational effects on aquatic ecology are assessed.

5.1.3 There would also be no in-river operational works however, during operation the interception of the combined sewer overflow (CSO) would result in reduced discharges of untreated sewage into the Tidal Thames at this location. 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 the downstream of the Greenwich Pumping Station 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, 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 assessment. This section assesses the localised effects at a site-specific level for the Greenwich Pumping Station 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* (Defra, 2012)[1]. In line with these requirements, designations, species and habitats relevant to aquatic ecology are identified and measures incorporated into the proposed development described. Based on assessment findings, measures to address likely significant adverse effects are identified. Vol.2 Section 5 provides further details on the methodology.

5.1.6 Plans of the proposed development as well as figures included in the assessment for this site are contained in a separate volume (Volume 24 Greenwich Pumping Station 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.

Operation

5.2.2 Discharges from the Greenwich Pumping Station CSO currently enter the Tidal Thames to the northeast of Deptford Creek in the Royal Borough (RB) of Greenwich. Discharges from the Greenwich Pumping Station CSO would be intercepted at the Greenwich Pumping Station site as part of the proposed development. Based on the base case (which includes permitted sewage treatment works upgrades, and the Lee Tunnel scheme, as well as projected population increases which have been modelled for 2021) discharges during the Typical Year[i] from the Greenwich Pumping Station CSO are anticipated to be 3,940,000m^3 per annum over a total of 28 discharge events (or spills) by 2021. The discharge is predicted to reduce to 573,000m^3 over four discharge events once the Thames Tideway Tunnel is operational. This represents an approximately 85% decrease in the volume of discharge as a result of the Thames Tideway Tunnel project.

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 24 Table 5.3.1.

5.3.2 When the *Scoping Report* was prepared, the Greenwich Pumping Station site included barging. Barging is no longer proposed. The scope for aquatic ecology for this site has therefore drawn on the scoping responses received for Greenwich Pumping Station pertinent to the current proposed development at the site.

Vol 24 Table 5.3.1 Aquatic ecology – stakeholder engagement for Greenwich Pumping Station

Organisation	Comment	Response
RB of Greenwich (Phase two consultation response – February 2012)	There are potentially a number of biodiversity compensation opportunities that can be introduced, and a detailed report suggesting these opportunities is being provided by the Council to the Thames Tideway Tunnel Biodiversity Technical Working Group	These schemes have been reviewed as part of the project wide compensation schemes (see Vol 3).
Environment Agency (Phase two	The scale of any interventions within the creek habitat should be considered within the	Noted. There would no longer be barging associated with the

[i] The 'Typical Year' represents the most 'typical' 12 month period of rainfall observed between 1970 and 2011 and covers the period from October 1979 to September 1980.

Organisation	Comment	Response
consultation response – February 2012)	*Environmental Statement*. It is an important fish habitat, with some survey data available for Deptford Creek and the non-tidal River Ravensbourne. Deptford Creek functions as refugia and foraging habitat for fish. Consequently, any loss of habitat or adverse impacts within the river corridor of the Creek are likely to have a much greater impact than in the main tidal Thames. The ecological receptor scoring should reflect the increased sensitivity of this (and any other) creek type habitats. There are few tributaries present in the middle tidal reaches of the Thames that retain their tidal nature. This makes them a valuable ecological resource in both the local context and for the upper tidal Thames.	Greenwich Pumping Station site and therefore the impacts on the Deptford Creek would no longer occur.
	Installation of a concrete platform as a campshed is likely to be more damaging to the creek than a frame. If a concrete campshed is the only option, the *Environmental Statement* will need to demonstrate the ability to remove the concrete campshed.	Noted. There would no longer be barging associated with Greenwich Pumping Station and therefore no campshed would be installed.
	The conditions at Borthwick Wharf are not similar to those in Deptford Creek, therefore you need to be wary in extrapolating survey data. The substrate and salinity at Borthwick Wharf is not similar to those in Deptford Creek, it is reasonable to suggest that species composition may be similar but productivity is likely to be much higher in Deptford Creek.	Noted and incorporated into the assessment. Borthwick Wharf is used as the conditions here are similar to the Greenwich Pumping Station CSO discharge location, which is in the Tidal Thames.

Baseline

5.3.3 The baseline methodology follows the methodology described in Volume 2. There are no site-specific variations for identifying the baseline conditions for this site.

5.3.4 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 Tideway. The data sets for fish, invertebrates and algae are based on fixed sampling locations at intervals through the Tideway. Locations as close to the Greenwich Pumping Station site as possible have been selected. Details of the background and data sets are provided in Volume 2.

5.3.5 Survey for fish and invertebrates collected during autumn 2010 at the Deptford Storm Relief discharge point at Borthwick Wharf, approximately 0.8km upstream from the confluence of Deptford Creek and the Tidal Thames, and during spring 2011 at Greenwich Pumping Station on the Deptford Creek. Survey data for fish and invertebrates were collected during spring 2011 on the Deptford Creek at the Greenwich Pumping Station site. During these surveys, the intertidal habitats present were recorded. As part of the project wide assessment, 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 at Bermondsey Wall East, approximately 4.5km upstream of the Greenwich Pumping Station CSO discharge site. Surveys for algae were undertaken at eight locations in May 2012, comprising each of the foreshore sites. The nearest sampling location to the Greenwich Pumping Station CSO discharge site was at King Edward Memorial Park Foreshore. The survey comprised sampling of algae along a vertical transect of the river wall.

Operation

5.3.6 The assessment methodology for the operation phase follows that described in Volume 2. The assessment area is the zone which lies within a 100m radius of the existing CSO discharge point. There are two assessment years for operational effects; Year 1 and Year 6. Year 1 is the year that the Thames Tideway Tunnel would be brought into operation. Year 6 provides sufficient time after operation commences to allow the longer term effects on aquatic ecology to be assessed. There are no site specific variations for undertaking the operational assessment of this site.

5.3.7 Section 5.6 details the likely significant effects arising from the operation of the proposed development at the Greenwich Pumping Station 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 Project wide assessment.

5.3.8 No other schemes from the site development schedule (Vol 24 Appendix N) are considered relevant to the aquatic ecology base case as none comprise in-river development, development adjacent to the river or development discharging into the river.

5.3.9 There are no schemes in the site development schedule that could lead to a cumulative impact at Greenwich Pumping Station. Therefore no cumulative impact assessment has been undertaken.

5.3.10 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

5.3.11 The assumptions and limitations associated with this assessment are presented in Volume 2. Assumptions and limitations specific to this site are outlined below.

Assumptions

5.3.12 There are no assumptions specific to the assessment of Greenwich Pumping Station.

Limitations

5.3.13 There are no site specific limitations.

5.4 Baseline conditions

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

Current baseline

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

Designations and habitats

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

5.4.4 The Tidal Thames is part of the 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)[2]. 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 (SSSI) or Local Nature Reserves (LNR)) designated for aquatic ecology within the assessment area.

5.4.6 The Greenwich Pumping Station CSO discharges directly into one non statutory site; the River Thames and Tidal Tributaries Site of Importance for Nature Conservation (Grade III of Metropolitan importance).)[ii]. The SINC is designated by the Greater London Authority (GLA), is adopted by all boroughs which border the Thames. It recognises the range and quality of estuarine habitats including mud flat, shingle beach, reedbeds and the river channel. 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, *Mercura 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)[3]. 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. The RB of Greenwich also has a HAP for the Tidal Thames (Greenwich Council, 2010)[4].

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 Volume 3.

5.4.9 The Greenwich Pumping Station CSO lies within the brackish zone, 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 At Borthwick Wharf, the nearest site surveyed to the Greenwich Pumping Station CSO discharge site, the subtidal substrate was found to consist of a heavily scoured bed consisting of pebbles and cobbles. The habitats at

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

Greenwich Pumping Station are considered to be comparable to those at Borthwick Wharf. The CSO discharge site is located within an area of the UK BAP priority habitat 'mudflats' (Natural England, undated)[5].

Evaluation of designations and habitats for Greenwich Pumping Station

5.4.11 The value of the habitats for individual aquatic ecology receptors is described in the relevant baseline sections. Habitats are considered to be of medium-high (metropolitan) value as part of the River Thames and Tidal Tributaries SINC (Grade M).

Marine mammals

5.4.12 Records compiled by the Zoological Society of London for 2003 – 2011 indicate that harbour porpoise (*Phocoena phocoena*), bottlenose dolphin (*Tursiops truncatus*) and seal species (grey seal (*Halichoerus grypus*) and common seal (*Phoca vitulina*)) migrate through the Tidal Thames. One record of harbour porpoise and nine records of seal (including seven common seal) were made from the Tidal Thames close to the current CSO discharge site.

Evaluation of marine mammals for Greenwich Pumping Station

5.4.13 The CSO discharge site is considered to be of low-medium (local) value for marine mammals given the small number of records of porpoise and seal. There is no evidence of use as a haul out site by seals.

Fish

5.4.14 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 site specific survey, relevant juvenile fish surveys and Environment Agency (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 Volume 3.

Baseline surveys

5.4.15 A single day survey was undertaken at Borthwick Wharf (Deptford Storm Relief CSO) during October 2010, located 0.8km upstream of the Greenwich Pumping Station CSO on the Tidal Thames. A single day survey was also undertaken at Greenwich Pumping Station of the Deptford Creek during May 2011. This survey data is included since the Deptford Creek is tidal, and therefore discharges from the Greenwich Pumping Station CSO close to the confluence of the Deptford Creek with the Tidal Thames could affect conditions within the Deptford Creek. Full details of the methodology and rationale for the timing of surveys are presented in Volume 2.

5.4.16 Fish are routinely categorised into 'guilds' according to their tolerance to salinity and habitat preference (Elliot and Taylor, 1989 [6], Elliot and

Hemingway, 2002)[7]. The species which occur in the Tidal Thames can be divided into the following four guilds:

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.

Tidal Thames

5.4.17 The single day of survey at Borthwick Wharf (Deptford Storm Relief CSO) during October 2010 recorded low to moderate fish numbers, with 66 individuals captured in total. Full details of the methodology are presented in Volume 2. The area covered by the survey is illustrated in Vol 24 Figure 5.4.1 (see separate volume of figures.)

5.4.18 This site ranked in the middle of the 15 sampling locations along the Tidal Thames. The lowest catch (at Albert Embankment Foreshore) was of 19 individuals. Six species were identified at Borthwick Wharf, the majority being smelt and common goby (*Pomatoschistus microps*). The range of species recorded and the number of individuals is presented in Vol 24 Table 5.4.1.

Vol 24 Table 5.4.1 Aquatic ecology – results of autumn 2010 fish surveys at Borthwick Wharf (Deptford Storm Relief CSO)

Common name	Scientific name	Number of individuals	Guild
Smelt	*Osmerus eperlanus*	26	Diadromous
Common goby	*Pomatoschistus microps*	18	Estuarine resident
Common bream	*Abramis brama*	12	Freshwater
Flounder	*Platichthys flesus*	8	Estuarine resident
Sand smelt	*Atherina presbyter*	1	Estuarine resident
Sea bass	*Dicentrarchus labrax*	1	Estuarine resident

5.4.19 This site reflects a widespread saline-tolerant fish community, except for the common ('freshwater') bream which may reflect the proximity of the site to the confluence with the Deptford Creek (approximately 300m).

Deptford Creek

5.4.20 A single day of survey at Greenwich Pumping Station (from the Ha'penny Hatch footbridge extending 136m upstream) on the Deptford Creek during May 2011 recorded only three species. The area covered by the survey is illustrated in Vol 24 Figure 5.4.1(see separate volume of figures). The range of species recorded and the number of individuals is presented in Vol 24 Table 5.4.2.

Vol 24 Table 5.4.2 Aquatic ecology – results of fish surveys at Greenwich Pumping Station

Common name	Scientific name	Number of individuals	Guild
Chub	*Leuciscus cephalus*	2	Freshwater
Eel	*Anguilla anguilla*	16	Diadromous
Flounder	*Platichthys flesus*	19	Estuarine resident

5.4.21 High numbers of 0+ year class juvenile flounder (15-30mm) were caught from this survey site. The flounder is usually considered an estuarine resident species, but juveniles are caught in annual EA surveys on the Tidal Thames, penetrating as far upstream as Teddington, using selective tidal stream transport (STST) to make upstream-headway (Wheeler, 1969) [8], (Wheeler, 1988)[9] in some (presumably dry) years, but only as far as Battersea in other years (Environment Agency unpublished survey data, 1992-2008). Four larger individuals between 125-295mm were caught in the May 2011 survey at Greenwich, representing several year classes from 1+ up.

5.4.22 Sixteen eels of sizes ranging between 200-625mm were also caught in this sample. This is the highest number of eels caught from a single survey site in either the 2010 or 2011 survey. Two chub (*Leuciscus cephalus*) were also caught in this sample. This is one of only two survey sites where chub has been recorded in any of the fish surveys, the other being at Bell Lane Creek, another tidally influenced tributary which flows with freshwater at low-water. Given the absence of other coarse fish in this reach, it is likely that these fish have been stranded here as the tide has receded.

Juvenile fish surveys

5.4.23 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.

5.4.24 Surveys for juvenile fish were undertaken as part of a suite of five sites sampled six times between May and September 2011 as part of the project wide assessment. The site locations are presented in Vol 2 Figure 5.4.4 (see separate volume of figures). The nearest sampling site to Greenwich Pumping Station CSO is at Bermondsey Wall East, approximately 4.5km upstream. The findings are however of some relevance to the Greenwich Pumping Station CSO site because it gives context to the assemblage of fish that may be expected to be found in this broad reach of the river. The aim of the surveys was to record juvenile fish migrations through the Tidal Thames 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.

5.4.25 The data from the juvenile fish surveys at the Bermondsey Wall East are shown in Vol 24 Table 5.4.3.

Vol 24 Table 5.4.3 Aquatic ecology – results of 2011 juvenile fish surveys at Bermondsey Wall East

Common name	Scientific name	Number of individuals					
		Survey					
		1 May	2 Late May	3 June	4 July	5 Aug.	6 Sept.
Flounder	*Platichthys flesus*	1	7	102	16	1	10
Smelt	*Osmerus eperlanus*	1	2	0	0	0	0
Eel	*Anguilla anguilla*	0	3	2	4	1	3
Common bream	*Abramis brama*	0	0	0	7	0	5
Dace	*Leuciscus leuciscus*	0	2	0	0	0	0
Roach	*Rutilus rutilus*	0	0	25	1	0	1
Perch	*Perca fluviatilis*	0	0	0	7	0	0
Goby	*Pomatoschistus* spp.	0	0	2	262	457	330
Sea bass	*Dicentrarchus labrax*	0	0	0	247	14	4
3-spined stickleback	*Gasterosteus aculeatus*	0	0	1	0	0	0
Zander	*Stizostedion lucioperca*	0	0	0	2	2	1

Common name	Scientific name	Number of individuals					
		Survey					
		1 May	2 Late May	3 June	4 July	5 Aug.	6 Sept.
Sand smelt	*Atherina presbyter*	0	0	0	2	1	0

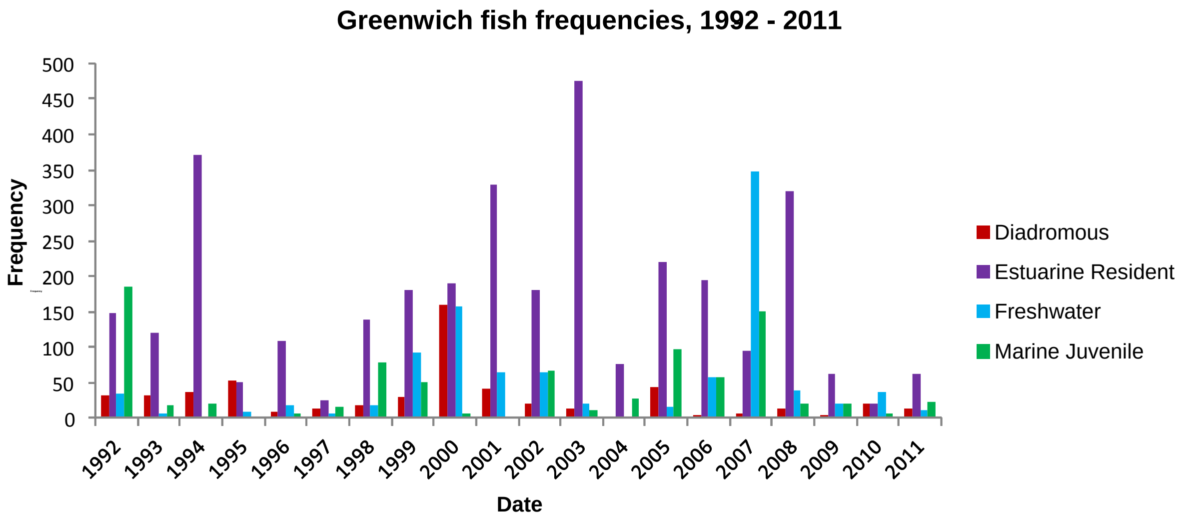
5.4.26 Post-larval flounders dominated the catch during survey three. Flounder were caught in the shallow littoral zone, indicating early springtime colonisation from marine spawning sites. In survey four, sea bass (*Dicentrarchus labrax*) and gobies were numerous, with numbers of gobies remaining high in surveys five and six. This indicates that Bermondsey Wall East is of importance for juvenile fish and that this broad stretch of the river is of value for juveniles, if not for adults.

Environment Agency background data

5.4.27 The EA carry out annual surveys of fish within the Tidal Thames using a variety of methods including trawling and seine netting, with data available from 1992-2011. The nearest sampling site to the Greenwich Pumping Station CSO discharge is Greenwich, located 0.4km downstream of the Greenwich Pumping Station CSO discharge site, where EA surveys have been carried out every year from 1992 to 2011.

5.4.28 Results from Greenwich show fairly steady catches in trawls but some indication of increasing seine-net catches in recent years (Vol 24 Plate 5.4.1). Catches are dominated by estuarine resident fish such as common goby, flounder and sand smelt, freshwater species including dace, common bream, perch and roach, and migratory species including eel and smelt. Other migratory species such as salmon and sea trout must pass through the area but are too infrequent 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 into the Tidal Thames and lower salinity conditions which allowed them to survive.

Vol 24 Plate 5.4.1 Aquatic ecology – long-term EA total fish catches from Greenwich site



5.4.29 In general, Tidal Thames fish populations are mobile and wide ranging, and hence any analysis of population data needs to be based on an understanding of the ecological requirements and migratory habits of individual species. Although the number per catch 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. Effects at this scale are assessed in Volume 3.

Water quality and current fish baseline

5.4.30 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 was recorded. The ecology of the Tidal Thames has undergone further improvement in recent decades, with some 125 fish species now recorded by the EA.

5.4.31 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 effect of a hypoxia event occurred in June 2011, in which approximately 26,000 fish were killed across the Tidal Thames 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 4)

5.4.32 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 (Water resources - surface water). Details of the TFRM are presented in Vol 2 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.

5.4.33 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 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 'life stage cases'), since juveniles generally have a lower tolerance to hypoxia.

5.4.34 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 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 (Volume 3 Section 5.5). However, TFRM results for the existing baseline suggest that a total of five of the seven species/life stage 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 Greenwich Pumping Station

5.4.35 The Greenwich Pumping Station CSO site is considered to be of medium-high (metropolitan) value for fish based on relatively high diversity of freshwater and estuarine species.

Invertebrates

5.4.36 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.

5.4.37 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

5.4.38 Two single day surveys were undertaken at Borthwick Wharf (Deptford Storm Relief CSO) during October 2010 and May 2011, located 0.8km upstream of the Greenwich Pumping Station CSO on the Tidal Thames. A single day survey was also undertaken at Greenwich Pumping Station of the Deptford Creek during May 2011. This survey data is included since the Deptford Creek is tidal, and therefore discharges from the Greenwich Pumping Station CSO close to the confluence of the Deptford Creek with the Tidal Thames could affect conditions within the Deptford Creek. Full details of the methodology are presented in Volume 2.

5.4.39 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.

Tidal Thames

5.4.40 No baseline data is available for the invertebrate communities in the immediate vicinity of the Greenwich Pumping Station outfall. However, the site lies approximately 0.8km downstream of Borthwick Wharf (Deptford Storm Relief CSO) where surveys were undertaken during October 2010 and May 2011. Two single day surveys were undertaken at Borthwick Wharf: one during October 2010 and one during May 2011. The area covered by the survey is illustrated in Vol 24 Figure 5.4.1 (see separate volume of figures). Further details of these methods can be found in Volume 2. Two intertidal and seven subtidal samples were taken during the October 2010 survey, and three intertidal and two subtidal samples during the May 2011 survey. The invertebrates collected during these surveys are presented in Vol 24 Table 5.4.4. and Vol 24 Table 5.4.5.

Vol 24 Table 5.4.4 Aquatic ecology – invertebrate fauna sampled at Borthwick Wharf (Deptford Storm Relief CSO) October 2010

Taxa	CCI score	No. of individuals - subtidal samples							No. of individuals - intertidal samples	
Sample numbers		Air lift D	Air lift1	Air lift 2	Air lift 3	Air lift 4	Air lift A	Air lift B	Sweep net 1	Sweep net 2
Theodoxus fluviatilis	3	0	0	0	0	0	0	120	0	0
Potamopyrgus antipodarum	1	15	0	0	0	0	100	350	0	0

Taxa	CCI score	No. of individuals - subtidal samples							No. of individuals - intertidal samples	
Assiminea grayana	2	0	0	0	0	0	20	0	0	0
Radix balthica	1	0	0	0	0	0	0	110	0	0
Sphaeridae	-	0	0	0	0	0	0	100	0	0
Nereis diversicolor	-	0	0	0	0	0	40	0	8	0
Oligochaeta	-	2	0	0	0	3	145	1500	2	0
Erpobdella testacea	5	0	0	0	0	0	1	12	0	0
Crangon crangon	-	6	6	6	0	0	45	0	0	1
Eriocheir sinensis	-	0	0	0	0	0	1	0	0	0
Lekanesphaera hookeri	2	0	0	0	0	0	1	0	3	0
Apocorophium lacustre	8	20	145	8	7	85	350	0	0	0
Corophium volutator	3	1	0	0	0	0	0	3	0	0
Gammarus sp	-	0	0	0	0	0	2	0	0	0
Gammarus zaddachi	1	6	0	0	0	0	100	140	0	1
Number of taxa	**-**	**6**	**2**	**2**	**1**	**2**	**11**	**8**	**3**	**2**

Vol 24 Table 5.4.5 Aquatic ecology – invertebrate fauna sampled at Borthwick Wharf (Deptford Storm Relief CSO) May 2011

Taxa	CCI score	No. of individuals - subtidal samples		No. of individuals - intertidal samples		
Sample numbers		**Air lift1**	**Air lift 2**	**Kick sample**	**Sweep net 1**	**Sweep net 2**
Potamopyrgus antipodarum	1	0	0	0	0	2
Polychaeta	-	84	2	3	150	100
Oligochaeta	-	0	4	0	50	75
Crangon crangon	-	1	0	0	2	1
Gammarus sp	-	1	0	0	0	0
Gammarus zaddachi	1	0	1	0	40	30
Gammarus tigrinus	1	0	0	0	1	0
Number of taxa	**-**	**3**	**3**	**1**	**5**	**5**

5.4.41 As at most other sites in the Tidal Thames, the invertebrate community was species poor and lacking in pollution sensitive taxa particularly in the intertidal samples. In contrast to sites further upstream, the intertidal samples were characterised by particularly low invertebrate diversity and abundance, with two to three pollution tolerant taxa and less than 20 specimens per sample (the lowest abundance of all sites and diversity among the least diverse). Subtidal samples however had significantly more diverse and abundant invertebrate fauna than intertidal samples (seven and ten taxa per sample). The most common species included *Radix balthica* (snails), *Sphaerium* spp. (pea mussels), Oligochaeta (worms) and *Gammarus zaddachi* (brackish water amphipod shrimp).

5.4.42 The samples taken in May 2011 show slightly higher abundances and diversity compared with October 2010, in the intertidal samples. However, overall, the invertebrate community is still characterised by low diversity and dominated by pollution tolerant groups Oligochaeta and Polychaeta worms. These apparently higher abundances and diversity in the intertidal samples in May are likely to be due to sampling and habitat variations. The presence of extensive areas of silt and mud (generally poor invertebrate habitat) is likely to explain the poor invertebrate diversity.

5.4.43 The low abundance or absence of taxa in the intertidal area is likely to be due to the very limited intertidal habitat at the site, the CSO discharge within the area and poor background water quality.

5.4.44 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* (shrimp, typical of estuarine and brackish conditions).

5.4.45 The only species of high nature conservation importance was *Apocorophium lacustre* (CCI 8), a Red Data Book (RDB) species, which was present in subtidal samples at the site in October 2010 but not in May 2011. EA data have however shown *A. lacustre* to be common in the Tidal Thames, and therefore the relative value of the invertebrate community is not considered to be of higher value in this instance.

5.4.46 Chinese mitten crab (*Eriocheir sinensis*), an invasive species, was sampled in the subtidal zone of the site in October 2010, but not in May 2011.

Deptford Creek

5.4.47 A single day of survey was undertaken at Greenwich Pumping Station on the Deptford Creek during May 2011. The area covered by the survey is illustrated in Vol 24 Figure 5.4.1(see separate volume of figures). Further details of these methods can be found in Volume 2. Two intertidal and two subtidal samples were taken.

5.4.48 Benthic invertebrates are used in the freshwater, estuarine and marine environments as biological indicators of water and sediment quality since their 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.

5.4.49 Whilst the abundance and diversity of invertebrate species at any one site provide a more accurate reflection of conditions at that site than site specific fish data, 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.

5.4.50 The invertebrates collected during the May 2011 field surveys are presented in Vol 24 Table 5.4.6. The CCI score (Chadd and Extence, 2004[15]) 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 RDB (Bratton, 1991[16], Shirt, 1987)[,17] The higher the CCI score the more scarce the species and/or greater its conservation value.

Vol 24 Table 5.4.6 Aquatic ecology – invertebrate fauna sampled at Greenwich Pumping Station

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**
Potamopyrgus antipodarum	1	170	45	40	20
Pisidium spp.	-	0	20	0	0
Pisidium casertanum (uncertain; damaged specimen)	1	3	0	0	0
Pisidium nitidum (uncertain; damaged specimen)	3	1	0	0	0
Polychaeta	-	0	10	0	3
Oligochaeta	-	90	270	200	300
Erpobdella testacea	5	2	0	1	0
Trocheta bykowskii	5	2	1	0	0
Haemopsis sanguisuga	5	0	1	0	0
Asellus aquaticus	1	5	0	1	0
Lekanesphaera hookeri	2	4	0	0	0
Cyarthura carinata	-	1	0	0	0
Apocorophium lacustre	8	0	1	0	0
Corophium multisetosum	2	0	0	0	1
Gammarus zaddachi	1	0	0	20	8
Diptera larvae	-	20	0	6	0
Chironomidae	-	50	45	10	0
Ceratopogonidae	-	0	0	2	0
Number of taxa	**-**	**11**	**8**	**8**	**5**

5.4.51 Subtidal samples taken at Greenwich Pumping Station survey site were characterised by high invertebrate diversity, while diversity is slightly lower for the intertidal samples.

5.4.52 As at other survey sites, pollution tolerant groups (Oligochaeta worms, Chironomidae midges, and the New Zealand mudshrimp *Potamopyrgus antipodarum*) dominate the invertebrate community, in terms of abundances, and the samples were characterised by the lack of pollution sensitive taxa. However, less pollution tolerant shrimp *G. zaddachi* was recorded in intertidal samples, although in low abundances. In the subtidal samples, no pollution sensitive taxa were recorded.

5.4.53 As at other survey sites, the taxa present were brackish species, with varying tolerance of different levels of salinity. The presence of more estuarine crustaceans (*Lekanesphaera hookeri, Cyarthura carinata*) than other survey sites is notable, indicating the greater estuarine influence of this survey site. Three species of leech and six species of crustaceans were recorded at this survey site.

5.4.54 None of the species present were of high nature conservation importance, as demonstrated by their CCI scores, with the exception of the mudshrimp *A. lacustre* (CCI 8, although this species is abundant in the Tidal Thames and its tributaries). However, it was found in very low abundance.

Environment Agency (EA) background data

5.4.55 The EA sampling site at Greenwich, 0.4km downstream of the Greenwich Pumping Station discharge site, has data taken using a number of techniques, including cores and kick sampling in the intertidal and day grab and core samples in the subtidal. Sampling at Greenwich was undertaken on an approximately monthly basis over the period 1989 and 1993 and 2006-2007.

5.4.56 A total of 35 taxa were recorded at Greenwich over the seven year period in which samples were collected. The taxa Oligochaeta, which thrives in organically polluted conditions was most abundant, together with other pollution tolerant species such as the snail *P. antipodarum*, Polychaeta worms (mostly *Boccardiella ligerica*), gastropod snails (*P. antipodarum* and Cochliopidae) and *G. zaddachi*.

5.4.57 In addition to the native *G. zaddachi*, the amphipod *Gammarus tigrinus*, of North American origin, was also relatively abundant in samples taken at Greenwich. It is believed that this species arrived in English waters via ballast water from ships. It lives in fresh and brackish waters and can expand rapidly, outcompeting local amphipods. However, based on available data, it appears to be much less abundant than the native *G. zaddachi* within the Tideway.

5.4.58 The majority of taxa present at Greenwich are brackish species, with varying tolerance of different levels of salinity from es*tuarine to* near freshwater. However, the increasing saline influence compared to upstream sites is demonstrated by the abundance of *L. hookeri* (a water louse) and various Polychaete worms (notably *B. ligerica* and *Marenzelleria viridis*), which are exclusively associated with estuarine or marine conditions.

Water quality and current invertebrate baseline

5.4.59 The influence of water quality, and specifically CSO discharges was investigated through statistical analysis of the EA invertebrate background data, Thames Tideway Tunnel baseline data, and EA water quality data. Although it was not possible to isolate trends over time at a site specific level, a number of observations were made that helps to identify the factors influencing invertebrate abundance and diversity. For example, certain species of Oligochaete worm, present at Borthwick Wharf/ Deptford Storm Relief CSO are indicative of polluted conditions because they are able to tolerate the low DO conditions and multiply rapidly in the enriched sediments.

5.4.60 The analysis is described in further detail in Vol 3 Section 9.4. The following summary is relevant to the brackish zone of the Tidal Thames in which the Greenwich Pumping Station CSO site is located.

5.4.61 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)[18]. This is generally attributed to the fact that relatively few invertebrates are adapted to considerable fluctuations in salinity. Other factors such as poor water quality and lack of habitat diversity, particularly in central London, are also likely to contribute.

5.4.62 Redundancy analysis[iii] (RDA) was used to compare the invertebrate dataset with water quality data for the period between 1992 and 2010. The analysis demonstrated the importance of environmental variables in determining the invertebrate communities in the 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 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 Greenwich Pumping Station

5.4.63 Greenwich Pumping Station is considered to be of medium (borough) importance due to the dominance of the invertebrate community by a limited range of pollution tolerant species. Only a single species of conservation importance (*A. lacustre*) was recorded, and it is ubiquitous within the Tidal Thames.

Algae

5.4.64 Algae occurs in the tidal Thames both in the water column and growing on the river wall and associated structures. The range of species which occur in the tidal Thames reflect salinity, habitat and environmental conditions. As well as their intrinsic value algal communities provide valuable habitat

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[iii] 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.

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

5.4.65 A single day survey was undertaken in May 2012 at King Edward Memorial Park foreshore, located approximately 3.5km upstream of Greenwich Pumping Station. Only six species of algae were recorded of which *Blidingia minima* is overwhelmingly dominant. All species are widespread and abundant in the Tidal Thames. All records are shown in Vol 24 Table 5.4.7.

Vol 24 Table 5.4.7 Aquatic ecology – marine algae sampled at King Edward Memorial Park Foreshore during 2012

Species	Survey observations	Species presence within the Thames Estuary
Blidingia marginata	Occasionally present on the river wall.	Widespread and abundant.
Blidingia minima	This species is dominant at all but the lowest level of the river wall.	Widespread and abundant.
Cladophora glomerata	Frequently present at the lowest level of the river wall.	Widespread and abundant.
Rhizoclonium riparium	Occasionally present on the lowest level of the river wall only.	Common in the estuary.
Ulva compressa	Occasionally present on the river wall.	Widespread and abundant.
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

5.4.66 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 Deptford, the closest to the CSO discharge point which is approximately 0.8km downstream. The records are shown inVol 24 Table 5.4.8.

Vol 24 Table 5.4.8 Aquatic ecology – marine algae sampled at Deptford 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.
Ulva intestinalis	Upper littoral on sea walls. Common in tidal Thames.
Ulva prolifera	Upper mid-littoral on sea walls and on floating structures above the water line. Widespread in the estuary
Urospora penicilliformis	Upper littoral on sea walls and floating structures just above the water line. Widespread in the Tidal Thames.
Gayralia oxysperma	Upper littoral levels on sea-walls in the middle reaches of the estuary. Recorded only since 1975.

Water quality and algal communities

5.4.67 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.

5.4.68 Studies of the pelagic algae (para. 5.4.64) 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)[19]. 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 led to a gradual process of recovery (Tittley, 2009)[20], although pollution tolerant species such as the green algal species still dominate the community.

Evaluation of algal community for Greenwich Pumping Station

5.4.69 None of the species recorded in Vol 24 Table 5.4.7 have protected or notable status (eg, 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

5.4.70 Using the baseline set out in paras. 5.4.1 to 5.4.69 the value accorded to each receptor considered in this assessment is set out in Vol 24 Table

5.4.9. The definitions of the receptor values and sensitivities used in this evaluation are set out in Volume 2.

Vol 24 Table 5.4.9 Aquatic ecology – summary of receptors and their values/sensitivities at Greenwich Pumping Station

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

Operational base case

5.4.71 The base case in Year 1 and Year 6 of operation 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 would be 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. Further, catchment modelling shows that the frequency, duration and volume of discharges from the Greenwich Pumping Station CSO would continue to rise due to population growth (spill volume and frequency as stated in para. 5.2.2: further details of the projected spills are presented in Section 14 [Water resources – surface water]). Therefore recovery due to water quality improvements would be suppressed at the Greenwich Pumping Station CSO discharge 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 would continue to be suppressed. Indeed, conditions in the immediate vicinity of the outfall may be more unfavourable for fish than the current baseline given the increase in frequency, duration and volume of CSO spills.

5.4.72 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 works upgrades at Mogden, these fluctuations are likely to be reduced. Whilst there may be minor changes, increases in abundance and diversity would however be limited by the fact that even with the Lee Tunnel and sewage works upgrades 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 freshwater zone, including the Greenwich Pumping Station CSO discharge site, would continue to be suppressed. and may also be less favourable than current baseline conditions because of the increased frequency, volume and duration of CSO spills.

5.4.73 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.

5.4.74 As stated in para. 5.3.8, there are no developments in proximity of Greenwich Pumping Station that are considered likely to alter the aquatic ecology baseline. Furthermore there is unlikely to be encroachment onto the tidal Thames foreshore for non-river dependent uses as this is restricted through the *London Plan* (Greater London Authority, 2011)[21] 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)[22] also presumes against developments riverward of the existing flood defences where these would, individually or cumulatively, change flows so that fisheries were affected or cause loss or damage to habitat. Therefore no change to current baseline from other developments is considered likely.

5.5 Construction effects assessment

5.5.1 As stated in para. 5.1.2, there would be no construction activities 'in-river' at this site therefore no significant effects on aquatic ecology are likely.

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

Increases in dissolved oxygen concentrations in the vicinity of the CSO

5.6.2 The projected Typical Year 85% decrease in the volume of discharges compared against the base case (para. 5.2.1) would result in improvements in DO concentrations at a local level and throughout the Tidal Thames, and would contribute to a river-wide improvement arising from the project. The Thames Tideway Tunnel improvements would ensure compliance with the DO standards described in para. 5.4.32. These improvements are assessed at a river-wide level in Vol 3. The impact is considered to be medium positive due to the relative large magnitude of the Greenwich Pumping Station CSO, and impacts would be near certain and permanent.

Reduction in sediment nutrient levels

5.6.3 Elevated concentrations of nutrients (phosphate and nitrate) are likely to have accumulated in the sediments in proximity to the 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

5.6.4 Sewage derived litter from the CSO can be expected to reduce by approximately 85%, from approximately 995t to approximately 145t, in the Typical Year with beneficial effects on aquatic ecology receptors. This is considered to be a low positive impact and would be near certain and permanent.

Operational effects

5.6.5 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.

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

Designations and habitats

Improvements in habitat quality through changes in water quality

5.6.7 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. Combining the low positive magnitude of impact with the medium-high (metropolitan) value of the resource and the likely recovery time of the habitats, the effects are considered to **negligible** at Year 1 increasing to **minor beneficial** by Year 6.

Marine mammals

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

5.6.8 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 marine mammals 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. . Combining the low positive magnitude of change with the low-medium (local) value of the resource, the effects are considered **negligible**.

Fish

Reduction in the occurrence of dissolved oxygen related fish mortalities

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

5.6.10 Interception of the Greenwich Pumping Station 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-high (metropolitan), the effect is thus considered to be **moderate beneficial**.

Increase in the distribution of pollution sensitive fish species

5.6.11 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, including salinity, substrate type and current, but pollution is known to be a considerable factor in determining colonisation (Maitland and Hatton-Ellis, 2003)[24]. Improving water and sediment quality would facilitate the spread of those pollution sensitive species which are currently being impeded by poor water and sediment quality.

5.6.12 EA data and bespoke project surveys have indicated no records of rare fish species in the vicinity of Greenwich Pumping Station CSO. Given that the impact is considered to be medium positive, and the value of the receptors is medium-high (metropolitan), the effect is thus considered to be **negligible** in the short term (Year 1), and **moderate beneficial** in the medium term (Year 6) since it would take time for fish species to colonise.

Improvement in the quality of foraging habitat

5.6.13 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. 5.6.7, and the invertebrate community becomes more diverse (paras. 5.6.14 to 5.6.19) foraging opportunities for fish may increase. Given that the impact is considered to be medium positive, and the value of the receptors is medium-high (metropolitan), the effect is considered to be **negligible** in the short term (Year 1), increasing to **moderate beneficial** in Year 6 of operation as it would take time for communities to develop.

Invertebrates

Localised improvements in invertebrate diversity and abundance

5.6.14 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 sewage treatment works 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.

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

5.6.16 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, E. and de Lafontaine, 2007)[25].

5.6.17 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 Year 1, rising to **minor beneficial** in Year 6 of operation as it would take time for new species to colonise.

Increase in the distribution of pollution sensitive invertebrate species

5.6.18 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.

5.6.19 EA data and bespoke project surveys have indicated one species of nationally rare (RDB) invertebrate (*A. lacustre*) present in the vicinity of the Greenwich Pumping Station 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

Changes in algal communities

5.6.20 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.

5.6.21 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 are considered to be **negligible** when considering the negligible impact magnitude and low-medium (local) receptor value.

Sensitivity test for programme delay

5.6.22 For the assessment of effects on aquatic ecology during operation, a delay to the Thames Tideway Tunnel project of approximately one year would not be likely to materially change the assessment findings reported above (paras. 5.6.1 to 5.6.22). This is because there are no developments in the site development schedule that would fall into the base case as a result of this delay and therefore the base case would remain as described in paras. 5.4.71 to 5.4.74.

5.7 Cumulative effects assessment

5.7.1 As described in Section 5.3, during the operational phase there are no schemes within the site development schedule that would have an impact on aquatic ecology receptors, and so no cumulative impacts with the proposed development would arise. Therefore the effects on aquatic ecology would remain as described in Section 5.6.

Sensitivity test for programme delay

5.7.2 In the event that the programme for the Thames Tideway Tunnel project is delayed by approximately a year, the cumulative effects assessment would remain unchanged. As described above in para. 5.7.1, 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

5.8.1 No mitigation is required at Greenwich Pumping Station since the effects on aquatic ecology receptors are associated only with the improvements in water quality arising from interception of the CSO.

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

5.9 Residual effects assessment

Operational effects

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

5.10 Assessment summary

Vol 24 Table 5.10.1 Aquatic ecology – summary of operational assessment

Receptor	Effect	Significance of effect		Mitigation	Significance of residual effect
		Year 1	Year 6		
Designated sites and habitats	Improvements in habitat quality through changes in water quality	Negligible	Minor beneficial	None	Minor beneficial
Marine mammals	Increase in the number and/or change in the distribution of marine mammals.	Negligible	Negligible	None	Negligible
Fish	Reduction in the occurrence of low dissolved oxygen related fish mortalities.	Moderate beneficial	Moderate beneficial	None	Moderate beneficial
	Increase in the distribution of pollution sensitive fish species.	Negligible	Moderate beneficial	None	Moderate beneficial
	Improvement in the quality of foraging habitat	Negligible	Moderate beneficial	None	Moderate beneficial
Invertebrates	Localised improvements in invertebrate diversity and abundance.	Negligible	Minor beneficial	None	Minor beneficial
	Increase in the distribution of rare and pollution sensitive invertebrate species.	Negligible	Minor beneficial	None	Minor beneficial
Algae	Changes in algal communities	Negligible	Negligible	None	Negligible

References

[1]Defra. *National Policy Statement for Waste Water* (2012).. Available at: http://www.defra.gov.uk/publications/files/pb13709-waste-water-nps.pdf last accessed November 2012

[2] Balanced Seas. *Marine Conservation Zone project – final recommendations* (September 2011).

[3] Thames Estuary Partnership Biodiversity Action Group. *Tidal Thames Habitat Action Plan*. Thames Estuary Partnership (undated).

[4] Greenwich Council. *Greenwich Biodiversity Action Plan*. (2010). Available at: www.royalgreenwich.gov.uk.

[5] Natural England. *Nature on the Map* (undated). Available at: http://www.natureonthemap.co.uk/map.aspx?m=bap. Last accessed January 2012.

[6] Elliott, M and Taylor, CJL. *The structure and functioning of an estuarine/marine fish community in the Forth estuary, Scotland*. Proc. 21st European Marine Biological Symposium (Gdansk). Polish Academy of Sciences, Institute of Oceanology, Warsaw, Poland, 227-240. (1989).

[7] Elliott, M and Hemingway, KL. *Fishes in Estuaries*. Blackwell Science (2002).

[8] Wheeler, A. *The Fishes of the British Isles and North-West Europe* (London: Macmillan). (1969)

[9] Wheeler, A.C. *Fish in Estuaries: a summing up.* J. Fish Biol. (Suppl. A), 251-254. (1988).

[10] Wheeler AC. *The Tidal Thames. The History of a River and its Fishes*. Routledge and Kegan Paul, London. (1979).

[11] Turnpenny, A.W.H., Clough, S.C., Holden, S.D.J., Bridges, M., Bird, H., O'Keeffe, N.J., Johnson, D., Edmonds, M., Hinks, C. . *Thames Tideway Strategy: Experimental Studies on the Dissolved Oxygen Requirements of Fish Consultancy Report no.FCR374/04 to Thames Water Utilities, Ltd*. Fawley Aquatic Research, Fawley Southampton, (April, 2004).]

[12] Chadd, R and Extence, C. *The conservation of freshwater macroinvertebrate populations: a community based classification scheme*. Aquatic Conservation: Marine and Freshwater Ecosystems, 14: 597-624. (2004).

[13] Bratton, J.H. (editor). B*ritish Red Data Books: 3. Invertebrates other than insects*. JNCC, Peterborough (1991).

[14] Shirt, D.B. (editor). *British Red Data Books: 2 Insects*. Peterborough: Nature Conservancy Council (1987).

[15] Chadd, R and Extence, C. See citation above.

[16] Bratton, J.H. (editor). See citation above.

[17] Shirt, D.B. (editor). See citation above.

[18] Bailey-Brock J.H., Paavo B., Barrett B.M. and Dreyer J.. *Polychaetes associated with a tropical ocean outfall: synthesis of a biomonitoring program off O'ahu Hawai'i*. Pac. Sci. 56: 459-479. (2002).

[19] English Nature. *Thames Estuary European Marine Site: English Nature's advice given under Regulation 33(2) of the Conservation (Natural Habitats & c.) Regulations 1994*. (2001).

[20] Tittley. *The Marine Algae (Seaweeds) of the Tidal Thames: a Floristic Account*. The London Naturalist. No.88. (2009).

[21] Greater London Authority. *London Plan.* (2011). Available at: www.london.gov.uk/priorities/planning/londonplan . Last Accessed May 2012

[22] Environment Agency. *National Encroachment Policy for Tidal Rivers and Estuaries* (2005)

[23] Turnpenny, A.W.H., Clough, S.C., Holden, S.D.J., Bridges, M., Bird, H., O'Keeffe, N.J., Johnson, D., Edmonds, M., Hinks, C. (2004). See citation above.

[24] Maitland, PS and Hatton-Ellis, TW. *Ecology of the Allis and Twaite Shad*. Conserving Nature Rivers Ecology Series No. 3. English Nature. (2003).

[25] Veilleux, E. and de Lafontaine, Y. *Biological synopsis of the Chinese mitten crab (Eriocheir sinensis)*. Fisheries and Oceans, Canada (2007).

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

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Thames Tideway Tunnel

Environmental Statement

Volume 24: Greenwich Pumping Station site assessment

Section 6: Ecology – terrestrial

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6 Ecology – terrestrial

6.1 Introduction

6.1.1 This section presents the findings of the assessment of the likely significant effects of the proposed development on terrestrial ecology at the Greenwich Pumping Station site.

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

a. site and vegetation clearance, and subsequent habitat reinstatement and creation

b. construction and site activities

c. temporary structures within the foreshore

d. 24 hour working associated with the connection tunnel drive and secondary tunnel lining.

6.1.3 Operational effects for terrestrial ecology for this site have been scoped out. This is on the basis that there would be no permanent operational lighting and maintenance works are limited to intermittent visits to site by maintenance personnel and vehicles. No significant operational effects are considered likely and for this reason only construction effects are assessed.

6.1.4 The following are not considered within the assessment:

a. Contaminated runoff and atmospheric pollution; as these would be controlled through the implementation of the *Code of construction practice (CoCP)*.

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

c. Invertebrate surveys were proposed at this site. However, the semi-improved grassland habitat that was of potential interest for invertebrates was removed between the initial Phase 1 Habitat Survey and the invertebrate survey. As the current habitats on site are unlikely to support notable invertebrate populations or assemblages, invertebrates are not considered in this assessment.

d. The presence of invasive plants listed on Schedule 9 of the Wildlife and Countryside Act 1981 (WCA 1981) as this would be managed in advance of site clearance and by the measures set out in the *CoCP*. However, the baseline includes the results of the invasive plants survey (para. 6.4.36).

6.1.5 The assessment of the likely significant effects of the project on terrestrial ecology has considered the requirements of the National Policy Statement

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

6.1.6 Plans of the proposed development as well as figures included in the assessment for this site are contained in a separate volume (Vol 24 Greenwich Pumping Station Figures).

6.2 Proposed development relevant to terrestrial ecology

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

Construction

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

a. removal of four trees from the eastern site boundary, one tree and an area of introduced shrub located to the north of the pumping station building, and a small area of amenity grassland

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

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

d. works to upgrade the interior of Greenwich Pumping Station.

Code of Construction Practice

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

Part A

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

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

b. a check of the site in advance of the works to identify any ecological constraints in addition to those discussed in this *Environmental Statement* (ES)

c. supervision of works by a suitably qualified ecologist

d. protection of trees

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

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

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

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

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

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

Part B

6.2.5 The *CoCP* Part B (Section 11) incorporates a measure to ensure replacement tree and scrub planting would be undertaken.

Embedded environmental measures

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

a. where practicable, trees removed would be replaced as close as possible to the current position or within close proximity to the site.

b. creation of low-maintenance wildflower grassland in areas not required for access

c. replacement tree planting on site.

6.3 Assessment methodology

Engagement

6.3.1 Vol 2 Environmental assessment methodology documents the overall engagement which has been undertaken in preparing the *Environmental Statement*. Specific comments relevant to this site for the assessment of terrestrial ecology are presented in the Vol 24 Table 6.3.1 below.

Vol 24 Table 6.3.1 Terrestrial ecology –stakeholder engagement

Organisation	Comment	Response
Environment	Highlighted that kingfishers	This information is

Organisation	Comment	Response
Agency and London Borough (LB) of Tower Hamlets (Biodiversity workshop – March 2011)	are regularly recorded in Greenwich along Deptford Creek. It is believed they may breed in Brookwin Park.	noted.
Environment Agency (Biodiversity workshop – March 2011)	Noted that the Creekside Education Centre, Deptford Creek, has been undertaking botanical surveys in the local area for a number of years. Commented that the area has potential to host rare species, including Thames Terrace invertebrates.	This information is noted and the Creekside Education Centre were included in invitations for project biodiversity workshops.
Royal Borough (RB) of Greenwich (phase two consultation response – February 2012)	There is an opportunity to enhance the landscape setting appropriate for black redstarts and biodiversity offer across the site, offering improved access to the waterway in the process. If possible a green roof or living wall should be incorporated for the benefit of black redstart.	The site would be reinstated following completion of works as described in para. 6.2.6. This includes a brown roof on the CSO drop shaft.
RB of Greenwich (phase two consultation response – February 2012)	Compensation schemes should be undertaken in the area.	No significant adverse effects have been identified for terrestrial ecology therefore compensation measures are not required (Section 6.7.2).

Baseline

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

a. desk study.

b. a Phase 1 Habitat Survey was undertaken on 17 December 2010 for the area of the site to the south of the DLR line (the southern section), and on 14 September 2011 the area of the site to the north of the DLR line (the northern section).

c. bat triggering surveys (remote recording surveys) were undertaken in the southern section of the site over three nights between 1 and 3 May 2011 for the majority of the site. The survey in the northern section of the site was undertaken over three nights between 14 and 16 September 2011.

d. bat activity (dawn) surveys were undertaken on 14 June 2011 for the southern section of the site, and on the 5 October 2011 for the northern section of the site.

e. bat emergence survey visits were undertaken at dusk on the 30 July 2012 and 2 August 2012, and a bat survey at dawn was undertaken on 3 August 2012 focussing on the Greenwich Pumping Station building.

f. breeding bird surveys were undertaken on 19 May, 9 and 14 June 2011.

g. wintering bird surveys were undertaken on 28 January, 28 February, 15 March, 20 October, 16 November and 15 December 2011.

h. black redstart (*Phoenicurus ochruros)* surveys were undertaken on 19 May, 9, 14 and 28 June, and 5 July 2011 in the southern section of the site, and 27 April, 9, 16 and 30 May, and 13 June 2012 for the northern section.

i. an invasive plant survey (species listed on Schedule 9 of the Wildlife and Countryside Act 1981) was undertaken on 2 September 2011 (southern section) and 21 September 2011 (northern section).

Construction

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

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

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

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

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

6.3.8 The following developments will be complete and operational during construction, unless otherwise stated, and have the potential to change the baseline conditions:

a. 83-87 Greenwich High Road adjacent to the south of the Greenwich Pumping Station site is to be redeveloped as retail/commercial and residential.

b. Greenwich Industrial Estate land, to the east of the site will be replaced by a mixed use development comprising residential units, education/office floor space, a health club, business units, an extension to the Community Centre, a nursery, retail foodstore floorspace, cafe/bike shop, hotels, a restaurant and public realm improvements. Landscaping is also included in the proposals comprising tree planting and planted raised beds.

6.3.9 The resulting change in baseline conditions is discussed in para. 6.4.41.

6.3.10 No change to the base case conditions for terrestrial ecology are considered likely from the proposed developments listed in the site development schedule (Vol 24 Appendix N) due to the isolated location of these developments from the proposed development site, within the urban context. Unless stated otherwise the developments will be complete and operational by Site Year 1 of construction.

6.3.11 Developments listed in the site development schedule (Vol 24 Appendix N) that would be under construction during construction at the Greenwich Pumping Station site are not considered within the cumulative effects assessment because they isolated from the site within the urban context.

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

Assumptions and limitations

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

Assumptions

6.3.14 It is assumed for the purposes of this assessment that the current use of the Greenwich Pumping Station site (described in Vol 24 Section 2) will continue as at present.

Limitations

6.3.15 Breeding bird surveys have been undertaken in the southern section of the site. The surveys were completed prior to the extension of the site boundary to the northern section of the site. The potential for notable nesting birds was not identified in the northern section of the sites due to the lack of suitable semi-natural habitat. Therefore there was no need for breeding bird surveys to be undertaken in this area. The assessment is considered to be robust based on the breeding bird survey data obtained.

6.3.16 No other site specific limitations have been identified.

6.3.17 Despite the limitations identified above, the assessment is considered robust.

6.4 Baseline conditions

6.4.1 The following section sets out the baseline conditions for terrestrial ecology within and around the site, including their value. Future baseline conditions (base case) are also described. All figures referred to in this section are contained in Vol 24 Greenwich Pumping Station Figures (see separate volume of figures).

Current baseline

Designated sites

6.4.2 The following designated sites relevant to terrestrial ecology are within 250m of the site and are shown on Vol 24 Figure 6.4.1 (see separate volume of figures):

a. The site is adjacent to Deptford Creek which is part of the River Thames and Tidal Tributaries Site of Importance for Nature Conservation (Grade III of Metropolitan importance[i]) and comprises inter-tidal habitat and river channel. This designated site is included in the aquatic ecology assessment (Section 5 of this volume) and is not considered further in this assessment.

b. Creekside Centre SINC (Grade I of Local importance[ii]) is located approximately 60m west of the site and comprises an environmental centre and mosaic of brownfield land habitat.

c. The Sue Godfrey Local Nature Reserve (LNR) is an urban park located approximately 180m to the north east of the site, adjacent to Deptford Church Street. It is also a designated SINC (Grade II of Borough importance[iii]). The site comprises a mixture of rough grassland, scrub and ruderal vegetation. More than 200 species of wild flowers, shrubs and trees have been recorded. It is of medium-high (metropolitan) value.

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

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

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

d. River Ravensbourne and Brookmill Park SINC (Grade B) is located approximately 245m southwest of the site and comprises a park through which the Ravensbourne River flows. Part of the park has been designated as a LNR.

Habitats

6.4.3 Habitats recorded within the survey area during the Phase 1 Habitat Survey are described in the table below and shown on Vol 24 Figure 6.4.2 (see separate volume of figures). Target notes (TN#) are indicated on this map and are referred to within the Vol 24 Table 6.4.1 below.

Vol 24 Table 6.4.1 Terrestrial ecology – Phase 1 Habitat Survey

Habitat type	Habitat description
Hardstanding	The majority of the site comprises hardstanding in the form of pathways and vehicle parking.
Buildings	A number of buildings associated with the pumping station are located on and adjacent to the site. The main pumping station building is located in the centre of the site and comprises a large brick building with apex roofing. Part of the building is disused (TN1). A brickbuilt ivy-clad chimney stack is located in the east of the site (TN2). An iron gantry associated with the rail lifting bridge over Deptford Creek is located immediately adjacent to the west of the site. This has a small wooden structure within it (TN3). A flat-roofed brick building is located adjacent to the River and rail lifting bridge with broken windows. The rail bridge (TN4) has a series of arches, a number of which are bricked up. However, the majority are bricked up at one end only. A number have small voids into the brickwork, or windows at one or both ends, some of which are open. The railway bridge walls and arches support ivy-leaved toadflax (*Cymbalaria muralis)* with occasional male fern (*Dryopteris filix-mas)* and hart's-tongue fern (*Asplenium scolopendrium)*. Within the northern section of the site, north of the railway bridge, there is a warehouse with intact brick walls and pitched steel roof (TN5) which is open with steel roof beams; an intact brick building (TN6), with a pitched, corrugated asbestos roof, which is used as a general store, and an intact brick building with a flat concrete roof close to the yard entrance (TN7). There is also a timber storage rack with steel canopy in the north of the site (TN8).
Amenity grassland	Areas of mown amenity grassland are present across the site. This habitat supports perennial rye-grass (*Lolium perenne),* daisy (*Bellis perennis)*, ribwort plantain (*Plantago lanceolata)* and creeping buttercup (*Ranunculus acris)*. The largest area of amenity grassland is in the southeast of the site. Pockets of amenity grassland are also located adjacent to buildings on site and in the

Habitat type	Habitat description
	main car parking area.
Tall ruderal	This habitat is found in unmanaged areas of the site, where there has been recent disturbance, and there are areas of nutrient-rich soil. Species comprise those typically found in brownfield urban environments, including common nettle (*Urtica dioica),* rough hawk's-beard (*Crepis biennis)* and hedge mustard (*Sisymbrium officinale).* Distinct areas of this habitat are located on the embankment behind the two steel-framed, open-sided units in the southwest of the site, and to the rear of the main pumping station.
Scattered scrub	A small area of scattered scrub is present to the north of the railway arches comprising butterfly-bush (*Buddleja davidii)*, elder (*Sambucus nigra)* and bramble (*Rubus fruticosus* agg.).
Introduced shrub	Pockets of dense, mature, ornamental shrub planting are present adjacent to vehicle parking areas. This habitat type includes two areas of Japanese knotweed *(Fallopia japonica)* (TN9 and TN10) (see para. 6.4.36)
Scattered trees	A number of coniferous and broadleaved trees are located on site, predominantly in the east. Species include poplar (*Populus)* sp and lime (*Tilia)* sp.
Running water and intertidal habitat	Deptford Creek is a tidal section of the River Ravensbourne and lies adjacent to the west of the site. The creek is canalised between concrete walls, and at low tide mudflats are exposed. There is some algal growth on the concrete walls. This habitat type is part of the aquatic ecology assessment (Section 5 of this volume).

6.4.4 The hardstanding on site is not considered to have any biodiversity value and is therefore considered to be of negligible value.

6.4.5 Buildings on site and immediately adjacent to the site have no intrinsic biodiversity value. However, the railway bridge walls and arches provide habitat for a number of plant species which are relatively common both in a Greater London and UK context. The walls are considered to be of low (site) value.

6.4.6 Areas of amenity grassland are species-poor, widespread across the site, and can easily be recreated. They offer some limited value as a semi-natural habitat within an otherwise urban area. This habitat is of low (site) value.

6.4.7 Tall ruderal vegetation is common both in a Greater London and UK context. Although this habitat is limited in extent, it offers some natural habitat within an otherwise urban area. This is considered to be of low (site) value.

6.4.8 The area of scattered scrub on site is of limited value due to the low diversity of species present and its small extent. Therefore, this habitat is considered to be of negligible value.

6.4.9 The introduced shrub mainly comprises non-native plant species and is small in extent. Therefore, this habitat is of negligible value.

6.4.10 Scattered trees are present on site. The native mature tree species present are common in the UK and the southeast of England. However, in the London metropolitan area and the RB of Greenwich, these species are less common due to the urban hard landscaping that dominates these areas. Therefore, scattered native mature trees are considered to be of low-medium (local) value.

Notable species

6.4.11 Survey results are set out in a notable species report, which is included in Vol 24 Appendix D.1. A summary of the results and an assessment of the value of species associated with the site are set out below.

Bats

6.4.12 During the Phase 1 Habitat Survey, potential for roosting bats was identified in the railway bridge and arches, the pumping station building and in the flat-roofed building adjacent to the river. It is considered that there is potential for bats to forage and commute along the lines of trees on site and along Deptford Creek. Consequently, remote recording surveys and a dawn activity survey were undertaken. A further two dusk emergence surveys and one dawn survey of the pumping station building were undertaken.

6.4.13 All bats are European Protected Species (EPS) under the Conservation of Habitats and Species Regulations 2010. Seven of the 18 bat species that regularly occur in England are listed as priority species on the UK BAP. Nine bat species are listed on the London BAP including common pipistrelle (*Pipistrellus pipistrellus)*, soprano pipistrelle (*Pipistrellus pigmaeus*), Nathusius' pipistrelle *(Pipistrellus nathusii)* and noctule (*Nyctalus nyctalus)*. These four species were all recorded on site. Detailed survey results are provided in Vol 24 Appendix D.1 and on Vol 24 Figure 6.4.3 (see separate volume of figures).

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

6.4.15 The remote recording survey identified high numbers of bat passes, with a maximum count of 187 common pipistrelle bats and 152 soprano pipistrelle bats during one night at one location (location two shown on Figure 6.4.3, adjacent to the south of the pumping station building). High numbers of common and soprano pipistrelle bat passes were recorded at location two adjacent to the pumping station building to the north. Small numbers of these species were recorded at location three within the northern section of the site. One noctule pass was recorded.

6.4.16 Several bat passes were recorded close to sunset and sunrise, which indicated a possible roost on or in close proximity to the site.

6.4.17 The dawn survey confirmed the presence of a common pipistrelle roost within the pumping station building with two individuals seen entering the building via the southeast corner of the roof at dawn. Other bat social calls were also heard and suspected of coming from inside the pumping station building. There is the potential for other parts of this building to be used by bats at different times of the year. The further surveys of the pumping station building did not identify the use of the pumping station by bats suggesting that the building is used intermittently through the active season. The data suggest that there may be other common and soprano pipistrelle roosts in close proximity to the site and bats from these roosts may forage on site.

6.4.18 One noctule was also recorded commuting along the eastern boundary of the pumping station site approximately an hour before dawn.

6.4.19 With consideration to the conservation status of common pipistrelle and soprano pipistrelle, and given the status of these species as priority species on the London BAP, the fact that both species are common and widespread in Greater London; the populations of bats on site is considered to represent a small number of bats relative to the UK populations.

6.4.20 Given the presence of a small common pipistrelle roost on site, and high levels of common pipistrelle bat activity, the population is considered to enrich the local biodiversity resource. Therefore, the common pipistrelle bat population is considered to be of low-medium (local) value.

6.4.21 The presence of high levels of soprano pipistrelle bat activity on site is considered to enrich the local biodiversity resource and the population is considered to be of low-medium (local) value.

6.4.22 Although noctule and Nathusius' pipistrelle bats are uncommon in comparison to both soprano and common pipistrelle bats, a single individual of either of these species is a small representation of the UK population. Therefore, the noctule and Nathusius' pipistrelle bat population associated with the site and immediate surroundings is considered to be of low (site) value.

Breeding birds

6.4.23 During the Phase 1 Habitat Survey, the semi-natural habitat, and the buildings and other structures both on and adjacent to the site were considered to have potential to support nesting birds. Therefore, breeding bird surveys were undertaken. Details of the breeding bird survey results are provided in Vol 24 Appendix D.1 and shown on Vol 24 Figure 6.4.4 (see separate volume of figures).

6.4.24 A total of 15 breeding bird species were recorded within the survey area. Of these, three are of conservation concern and are included on the Birds of Conservation Concern (RSPB, 2009)[5] Red or Amber List[iv] and/or UK and London BAP as priority species (Vol 24 Table 6.4.2). The records of birds of nature conservation importance recorded within the survey area were compared to counts at other sites published in the London Bird Report 2008 (London Natural History Society, 2011)[6].

6.4.25 The three species of conservation concern are as follows:

a. stock dove (*Columba oenas)* recorded in trees to the southeast of the site

b. grey wagtail *(Motacilla cinerea)* recorded adjacent to the site near to the footbridge over the adjacent Deptford Creek

c. dunnock (*Prunella modularis)* recorded in the south of the site.

6.4.26 Breeding bird territories were primarily recorded within established tree and shrub vegetation to the south of the pumping station building (both on and adjacent to the site) and associated with the mature treeline to the east of the site.

6.4.27 Breeding bird species associated with the Greenwich Pumping Station site were recorded at low numbers relative to their London populations (London Natural History Society, 2011)[7]. Therefore, each species of conservation concern was considered to be of low-medium (local) value. The remaining species would not be considered to be of importance individually at more than low (site) level.

Vol 24 Table 6.4.2 Terrestrial ecology – breeding birds of nature conservation importance

Common name	Scientific name	Nature conservation designation	Number of breeding territories	Value
Stock dove	*Columba oenas*	Amber List	1	Low-medium (Local)
Grey wagtail	*Motacilla cinerea*	Amber List	1	Low-medium (Local)

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

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

Common name	Scientific name	Nature conservation designation	Number of breeding territories	Value
Dunnock	*Prunella modularis*	Amber List and UK and London BAP Priority List	2	Low-medium (Local)

Wintering birds

6.4.28 During the Phase 1 Habitat Survey, the foreshore adjacent to the site was considered to have potential to support wintering bird species. Therefore, wintering bird surveys were undertaken. Details of the wintering bird survey results are provided in Vol 24 Appendix D.1 and shown on Vol 24 Figure 6.4.5 (see separate volume of figures).

6.4.29 A total of ten waterbird species were recorded within the survey area. Of these, seven are of conservation concern and are included on the Birds of Conservation Concern 35 Red or Amber List and/or UK and London BAP as priority species (

6.4.30 Vol 24 Table 6.4.3):

a. The intertidal foreshore is used for foraging by mallard *(Anas platyrhynchos)*, herring gull *(Larus argentatus)*, black-headed gull *(Chroicocephalus ridibundus)*, common gull *(Larus canus)*, lesser black-backed gull *(Larus fuscus)* and great black-backed gull *(Larus marinus*).

b. Common kingfisher *(Alcedo atthis)* was recorded flying along Deptford Creek. Due to the lack of suitable habitat, it is considered unlikely that kingfisher are breeding on or immediately adjacent to the site.

6.4.31 The records of waterbirds of nature conservation importance recorded on the foreshore on and adjacent to the site were compared to counts at other sites published in the London Bird Report 2008 (London Natural History Society, 2011)[8].

6.4.32 The seven species of conservation concern were recorded in low numbers and are each considered to be of low-medium (local) value. The remaining three waterbird species would not be considered to be of importance individually at more than low (site) level. However, as an assemblage of wintering waterbirds, they appreciably enrich the local area. Therefore, the waterbird assemblage is considered to be of low-medium (local) value.

Vol 24 Table 6.4.3 Terrestrial ecology – wintering birds of nature conservation importance

Common name	Scientific name	Conservation designation[v]	Comments	Value
Mallard	*Anas platyrhy-nchos*	Amber List	Recorded in January, February, March and December, with a maximum count of 14 in February 2011, and with numbers varying between three and nine in other months.	Low-medium (local)
Black-headed gull	*Larus ridibundus*	Amber List	Recorded in all months, with a maximum count of 53 in March 2011, and numbers varying between nine and 44 in other months.	Low-medium (local)
Common gull	*Larus canus*	Amber List	Recorded in January, November and December, with a maximum count of eight in December 2011, and numbers varying between one and seven in other months.	Low-medium (local)
Lesser black-backed gull	*Larus fuscus*	Amber List	Recorded in January 2011 only, numbering one individual.	Low-medium (local)
Herring gull	*Larus argentatus*	Red List and UK and London BAP Priority List	Recorded each month except for March 2011, with a maximum count of two individuals each month, except December 2011 where one individual was recorded.	Low-medium (local)

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[v] A species that is listed in the following publications:

Batten, LA, Bibby, CJ, Clement, P, Elliot, GD, and Porter, RF. *Red Data Birds in Britain*. T. and A.D. Poyser, London. (1990).

Commission of the European Communities. Council Directive 79/409/EEC on the Conservation of Wild Birds. *Official Journal of European Communities, L103*. (1979).

Holliday, M & Rare Breeding Bird Panel. Rare Breeding Birds in the United Kingdom in 2009. *British Birds*, 104, 9, 476-537. (2011).

Royal Society for the Protection Birds. *Birds of Conservation Concern 3*. RSPB, Sandy. (2009).

United Kingdom Biodiversity Action Plan Steering Group. *United Kingdom Biodiversity Action Plan* http://jncc.defra.gov.uk/page-5163 [10.11]. (2011).

Common name	Scientific name	Conservation designation[v]	Comments	Value
Great black-backed gull	*Larus marinus*	Amber List	Recorded in December 2011 only, numbering one individual.	Low-medium (local)
Kingfisher	*Alcedo atthis*	Amber List Schedule 1 of the Wildlife and Countryside Act 1981.	Recorded in October 2011 only, numbering one individual.	Low-medium (local)

Black redstart

6.4.33 The Greenwich Pumping Station site is considered to have the potential to support nesting black redstart as this species has been recorded within 500m of the site, and the buildings and structures on site could potentially provide nesting sites for this species. Therefore, black redstart surveys have been undertaken. Full results are provided in Vol 24 Appendix D.1 and shown on Vol 24 Figure 6.4.6 (see separate volume of figures).

6.4.34 The Rare Breeding Birds Panel for the UK reported that 20–54 pairs of black redstart were identified at 49 sites in 2008, with birds reported from 21 counties nationally (Holling and Rare Breeding Birds Panel, 2008)[9]. The population in London therefore represents between 10% and 30% of the UK population (RSPB, 2012)[10].

6.4.35 Black redstart is listed on Schedule 1 of the Wildlife and Countryside Act 1981 (as amended). This protects the bird, its eggs and nestlings from killing, injury, and damage or destruction to its nest. The Act also protects black redstart from any intentional disturbance to the bird while it is building its nest, or is in, on or near a nest containing eggs or young, or disturbance of the dependent young.

6.4.36 Whilst the desk study identified records of black redstart within 500m of the site, black redstart was not recorded during the 2011 survey. There is considered to be no current black redstart resource on or in close proximity to the site and the black redstart resource is considered to be of negligible value. Black redstarts are not considered further in this assessment.

Invasive plants

6.4.37 Japanese knotweed was recorded in two locations within the Greenwich Pumping Station site boundary as shown on Vol 24 Figure 6.4.7 (see separate volume of figures). Japanese knotweed is listed in Schedule 9 Part II of the Wildlife and Countryside Act 1981 (as amended). It is illegal to cause this species to spread or grow in the wild. Invasive plants are not considered further within this assessment as the eradication and control of such invasive species would be managed by the measures set out in the *CoCP*, as discussed in para. 6.1.4d.

Noise, vibration and lighting

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

6.4.39 Current sources of noise and vibration are mainly derived from the activities of the operational pumping station. Activities include vehicle movement and general operational and maintenance activities.

6.4.40 At night the pumping station is lit. The site is also subject to low levels of light spill due to high background ambient levels.

Construction base case

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

6.4.42 Whilst the schemes described in para. 6.3.8 would constitute a change to the surrounding area, the existing landuse of these development sites currently comprise buildings and hardstanding and the landscape planting proposed as part of these developments would be immature. Therefore, no change in ecological value of the Greenwich Pumping Station site or surrounding area is considered likely by Site Year 1 of construction. No other developments are considered likely to change the ecological baseline.

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

6.4.44 No change in light conditions are anticipated.

6.5 Construction effects assessment

Construction impacts

Habitat clearance and creation

6.5.1 Habitat of low-medium (local) value and of low (site) value would be removed as part of construction works. This habitat comprises amenity grassland, mature trees, introduced shrub planting and tall ruderal vegetation. This would affect breeding birds that nest and forage within this habitat, and bats that forage and commute on site. Tree lines in the east of the site would be maintained although shortened by the removal of the three trees for site access. Mature trees and grassland habitat within the wider pumping station site would also be retained.

6.5.2 The pumping station would be subject to internal works although the main structure of the building would not be altered. Several buildings that are considered likely to support small numbers of nesting birds in the north of the site would be demolished during construction.

6.5.3 The bat roost identified in the pumping station building would be maintained during construction and any potential disturbance to bats would be managed through the CoCP Part A (Section 11) and *CoCP* Part B.

6.5.4 Replacement trees, scrub and wildflower grassland would be provided on completion of works, resulting in no overall loss in habitat on site.

Movement, noise, vibration and lighting

6.5.5 Noise and vibration impacts are based upon the data and assessment in Section 9 of this volume. Noise and vibration levels are likely to increase during construction with the greatest increases in noise levels experienced during site clearance (building demolition) and during shaft sinking (mainly from piling). These activities could cause disturbance to wintering birds on the foreshore adjacent to the site and any birds breeding adjacent to the site.

6.5.6 Noise and vibration levels are considered likely to increase at Lots Road Pumping Station during works to the pumping station and during the demolition of adjacent buildings, which could cause disturbance to roosting bats, if present. Measures would be in place as part of the *CoCP* Part B (Section 11) to avoid and/or mitigate any such disturbance.

6.5.7 Background light levels are high. With measures in place as part of the *CoCP*, it is considered likely that additional light spill from the site onto adjacent habitats would be minimal. No impacts on species from lighting are anticipated.

6.5.8 The movement of construction workers and machinery on site could disturb birds adjacent to the site during construction. Activities within the coal shed buildings are unlikely to disturb bats given that they are in current use.

Construction effects

Habitats

6.5.9 The habitats to be lost during construction comprise habitats of low-medium (local) value and low (site) value. As a result of habitat creation and reinstatement following completion of the works, the temporary loss of all habitats is considered to be probable, **negligible** and not significant.

Species

Bats

6.5.10 The loss of foraging habitat on site would be minimal in view of the extent of retained foraging habitat on and adjacent to the site. Bats would be displaced to alternative habitat and would return to site following the reinstatement of habitat on site. The overall effect on bats due to temporary habitat loss is considered to be probable, **negligible** and not significant.

6.5.11 Noise and vibration from construction activities within the Greenwich Pumping Station site, demolition of buildings in the north of the site, and the construction works within the pumping station may disturb bats that are likely to be roosting within the building. However, measures such as those detailed in the *CoCP* mean that it is considered unlikely that there would be any significant change to populations of bats on site. Therefore, this effect is considered to be probable, **negligible** and not significant.

6.5.12 Small changes in light levels are considered unlikely to create a barrier to the movement of commuting bats. Common and soprano pipistrelle bats can tolerate relatively high light levels, up to 14 lux. There may be some minor changes in bat behaviour as bats are likely to commute over or around the works. The vegetation retained on site and in the surrounding area would remain dark corridors for the movement of bats, and the function of this habitat would be maintained. It is considered unlikely that changes in light levels and minimal changes in commuting behaviour would have an effect on the local distribution and abundance of bat populations. Therefore, the effect is considered to be probable, **negligible** and not significant.

Breeding birds

6.5.13 The temporary loss of breeding bird foraging and nesting habitat is considered to be small relative to the availability of breeding habitat within the wider area, for example within the nearby Greenwich Park. Trees would be replaced upon completion of works. Therefore, the temporary loss of habitat is unlikely to result in a reduction in breeding bird populations within the Greenwich Pumping Station compound. Any birds displaced as a result of habitat clearance are considered likely to move to alternative areas. Small fluctuations in population would not be discernible from background population fluctuations. Therefore, the effect of habitat clearance is considered to be probable, **negligible** and not significant.

6.5.14 Any birds nesting adjacent to the site (associated with vegetation retained in the wider pumping station site and that associated with Deptford Creek) are likely to habituate to small changes in noise and vibration levels. Therefore, the effects of disturbance on breeding birds are considered to be probable, **negligible** and not significant.

Wintering birds

6.5.15 Noise and vibration associated with construction activities on site would increase during construction. It is considered likely that small numbers of waterbirds would displace to adjacent foreshore areas along the watercourse. This displacement effect would be reversed following completion of the works. No change in wintering bird populations is anticipated as a result of such displacement. Therefore, the effect of noise and vibration on wintering waterbirds at the site is considered to be probable, **negligible** and not significant.

Sensitivity test for programme delay

6.5.16 For the assessment of effects on terrestrial ecology during construction, a delay to the Thames Tideway Tunnel project of approximately one year would not be likely to materially change the assessment findings reported above (paras. 6.5.1 - 6.5.15). This is because there are no developments in the site development schedule (Vol 24 Appendix N) that would fall into the base case as a result of this delay and therefore the base case would remain as described in paras. 6.4.40 - 6.4.43.

6.6 Operational effects assessment

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

6.7 Cumulative effects assessment

Construction effects

6.7.1 There are no developments in the vicinity of Greenwich Pumping Station site to be considered in the cumulative effects assessment. Therefore the effects on terrestrial ecology would remain as described in paras. 6.5.9 - 6.5.16.

Sensitivity test for programme delay

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

6.8 Mitigation

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

6.9 Residual effects assessment

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

6.10 Assessment summary

Vol 24 Table 6.10.1 Terrestrial ecology – summary of construction assessment effects

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Habitats				
Buildings, hard standing, amenity grassland, tall ruderal vegetation, scattered scrub, introduced shrub and scattered trees.	No significant change in the habitat resource on site as the habitats to be removed would be reinstated and created upon completion of works.	Negligible	None	Negligible
Species				
Bats	No significant changes in bat populations as a result of a temporary loss of foraging habitat.	Negligible	None	Negligible
	No change in bat populations due to noise and vibration associated with works to Greenwich Pumping Station site, demolition of buildings and construction activities on site.	Negligible	None	Negligible
	No significant changes in bat populations as a result of temporary lighting during construction.	Negligible	None	Negligible
Breeding birds	No significant changes in populations of breeding birds due to the temporary loss of habitat and replacement of habitat following	Negligible	None	Negligible

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
	completion of works.			
	No significant changes in breeding bird populations as a result of disturbance from noise and vibration.	Negligible	None	Negligible
Wintering birds	No significant changes in wintering bird populations as a result of low levels of disturbance from noise and vibration.	Negligible	None	Negligible

References

[1] Department of Environment, Food and Rural Affairs (Defra). *National Policy Statement for Waste Water*. (2012). Available at: http://www.defra.gov.uk/publications/files/pb13709-waste-water-nps.pdf last accessed November 2012

[2] IEEM. *Guidelines for Ecological Impact Assessment in the United Kingdom* (2006).

[3] London Bat Group. *Greater London Bat Action Plan* (2012). Available online at: http://londonbats.org.uk/lbpsap.htm. Accessed January 2012.

[4] Harris S., Morris, P., Wray, S. and Yalden, D. *A review of British mammals: population estimates and conservation status of British mammals other than cetaceans*. JNCC, Peterborough (1995).

[5] Royal Society for the Protection of Birds. *Birds of Conservation Concern 3*. RSPB, Sandy (2009).

[6] London Natural History Society. *London Bird Report 2008*. London Natural History Society (2011).

[7] London Natural History Society. See citation above.

[8] London Natural History Society. See citation above.

[9] Holling and Rare Breeding Birds Panel. *Rare breeding birds in the United Kingdom in 2008*. (2008).

[10] Royal Society for the Protection of Birds (RSPB). *Black Redstart.* Last updated January 2012. Available online at: http://www.rspb.org.uk/wildlife/birdguide/name/b/blackredstart/index.aspx. Accessed January 2012.

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.24**

Volume 24: Greenwich Pumping Station site assessment

Section 7: Historic environment

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Thames Tideway Tunnel

Environmental Statement

Volume 24: Greenwich Pumping Station 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 on the historic environment at the Greenwich Pumping Station site. The historic environment is defined in para 4.10.2 of the NPS as including all aspects of the environment resulting from the interaction between people and places through time, including all surviving physical remains of past human activity, whether visible, buried or submerged, and landscaped and planted or managed flora. For the purposes of this assessment, heritage assets comprise below and above-ground archaeological remains, buildings, structures, monuments and heritage landscapes within and around the site. Effects during construction and operation are assessed with effects on buried heritage assets presented first, followed by above-ground assets.

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

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

7.1.4 The operational phase would not involve any activities below ground aside from maintenance within the tunnel infrastructure. Therefore an assessment has not been undertaken of operational effects on buried assets.

7.1.5 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 effect of the proposed development on the significance of heritage assets is clearly detailed in line with the requirements of the NPS. The role of the design process in helping to minimise effects on the historic environment is explained, and where appropriate, mitigation is proposed. Vol 2 Section 7 provides further details on the methodology.

7.1.7 Plans of the proposed development as well as figures included in the assessment for this site are contained in a separate volume (Volume 24 Greenwich Pumping Station Figures).

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. These are described below.

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

7.2.4 Initial site setup works would also require removal of the former Beam Engine Cooling System pond liner, existing pipework, chambers, well and covers associated with the Beam Engine (see Demolition and site clearance plan 2, separate volume of figures - Section 1), the existing portacabins in front of Greenwich Pumping Station and demolition of buildings to the north of the railway lines (see Demolition and site clearance plan 1, separate volume of figures - Section 1).

7.2.5 The permanent works would include deep excavations for the construction of a combined sewer overflow (CSO) drop shaft (see Construction phases - phase 1 plan, separate volume of figures - Section 1), and an interception and valve chamber. It would include a ventilation duct connecting the CSO drop shaft to ventilation equipment and outlets in the existing East Beam Engine House.

7.2.6 The excavations within and immediately around Greenwich Pumping Station would cause ground movement that could potentially cause damage to the listed building.

7.2.7 Ventilation equipment would be housed within the existing unused Grade II listed East Beam Engine House (see Site works parameter plan, separate volume of figures - Section 1).

7.2.8 Alterations to the existing fabric would be kept to a minimum and would comprise:

a. The refurbishment of windows to incorporate vents.

b. The temporary removal of the stairs to the west of the northern entrance podium for the interception chamber. The existing auxiliary pump chamber here would be demolished and its York stone roof with pavement light reused close to its original position.

c. The removal of wooden doors on small vents at first floor level on the south elevation to reuse the original openings to expel air.

d. Replacing the 1950s concrete floor with a new concrete floor over which would be set the new ventilation equipment.

e. The northern end of the east wall of the East Beam Engine House would be broken out locally below the external ground level, to allow a new 1.2m diameter buried ventilation duct to enter the building.

f. Small (maximum 650x350mm) localised openings for cable ducting routes and entry for a dry riser. All made below ground level where possible.

g. Internal fixing of lighting and associated small power services to the new ventilation plant.

h. Reopening of original doorway into boiler house building, in line with the project design principles which state that existing or original penetrations would be re-used for new openings. Installation of a fire door here.

i. Modifications to existing main entrance door to comply with security requirements (new ironmongery).

j. Removal of modern “keylock” guarding on podium. Refurbishment of original guarding and relocation of balusters from the auxiliary chamber access stair to podium if necessary.

k. Refurbish existing lantern if required, based on a thorough understanding of the nature and significance of the asset.

7.2.9 All works to the listed Beam Engine House are shown in the following plans (see separate volume of figures – Section 1):

a. Existing floor plan with extent of loss

b. Proposed floor plan

c. Listed building internal elevations with extent of loss

d. As existing beam engine house south elevation with extent of loss

e. Proposed beam engine house north elevation

f. Proposed beam engine house south elevation

g. Proposed beam engine house east elevation

h. Listed structure interface - entrance door

i. Listed structure interface - windows

7.2.10 Ground intrusion from tree planting and root action, and paving as part of landscaping works (see ‘zone within which landscaping would be located’ in the Site works parameter plan, separate volume of figures - Section 1) is assumed for the purposes of this assessment to reach a depth of approximately 1.5mbgl.

7.2.11 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 the CSO drop shaft construction sinking and secondary lining of the tunnel

c. provision of welfare facilities

d. lighting of the site when required.

Code of Construction Practice

7.2.12 Measures incorporated into *the Code of Construction Practice* (*CoCP)* Part A (Section 12) to protect heritage assets include:

a. The requirement for the contractor to prepare a site-specific *Heritage Management Plan* (*HMP*), indicating how the historic environment is to be protected. This may take form of both physical protection and working practices. It would also address any effects from third-party impacts, vibration, ground movement and dewatering.

b. Protective measures, such as temporary support, hoardings, barriers, screening and buffer zones around heritage assets, and archaeological mitigation areas within and adjacent to worksites.

c. Advance assessment to inform the types of plant and working methods for use where heritage assets are close to worksites, or attached to structures that form parts of worksites.

d. Where elements to be demolished are attached to listed structures being retained, they would be separated where practicable, prior to demolition, using non-vibratory techniques such as diamond sawing.

e. 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.

f. 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'.

g. 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.

h. Procedures in the event of the discovery of human remains.

i. Procedures under the Treasure Act Code of Conduct 1997, to address the discovery of any artefacts defined in the Treasure Act 1996.

7.2.13 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).

7.2.14 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.

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

a. An archaeological standing structure survey of the East Beam Engine House, including the temporary removal of steps, in order to mitigate effects of modifications and provide a record to act as a guide to repairs and reinstatement.

b. The existing stairs attached to the East Beam Engine House would be dismantled, stored and re-assembled.

c. Protective measures would be put into place to prevent strike damage to the Grade II listed Beam Engine Houses and central Boiler House (HEA 1A), the Grade II listed coal sheds (HEA 1B and 1C), and the Grade II listed Network Rail Viaduct (HEA 1F).

7.2.16 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 a *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 7.8.7.

Operation

7.2.17 The operation of the proposed development at Greenwich Pumping Station site is described in Section 3 of this volume. The particular components of importance to this topic include the treatment of the surrounding grounds, and the design and siting of the proposed ventilation structure and electrical kiosk.

7.2.18 The operational design has been developed through close liaison with stakeholders, including English Heritage, and in response to early iterations of the environmental impact assessment, through a series of design workshops, as well as in response to other design factors, such as operational requirements. The design process has therefore helped to minimise effects on the character, appearance and setting of heritage assets. Such design decisions are 'embedded' within the proposed development which has been assessed. Alternatives to the project, including design iterations, are fully detailed in Section 3 of this volume.

Historic environment design measures

7.2.19 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. The following generic design principles which apply to this site are relevant because they would inform the final appearance of the operational scheme:

a. Principles relating to the integration of functional components that apply to the sites, including those dealing with; efficient use of land, high quality design and minimising areas of hardstanding. This is because they would inform the appearance of the completed operational infrastructure.

b. All the heritage principles which apply to this site. These aim to safeguard significances and embody established conservation principles.

c. All the landscape principles which apply to this site. These include hard and soft landscaping, materials and public accessibility.

d. All the lighting principles which apply to this site. These include matters relating to safety, aesthetic effects, and the quality of fittings.

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

a. For hydraulic reasons, the design would accommodate the raised level required for the CSO drop shaft structure and be designed in line with the overall architectural and landscape design for the site. The shaft would have a low maintenance brown roof with integrated covers.

b. Fences or railings would be in keeping with the context.

c. Any York stone slabs removed by construction works would be reused for the roof of the interception chamber. If this is not possible, it would be finished in fair faced concrete consistent with the functional nature of the chamber and its context.

d. The existing glazing of the East Beam Engine House would be renovated /replaced as required. Any alterations to the glazing to accommodate the reuse of the building would be designed to be sensitive to the building’s significance.

e. No new lighting would be provided except for low level lighting to the steps to the shaft which would only be used during maintenance activities. Existing lighting would be replaced like for like.

f. Trees removed to improve access would be replaced elsewhere on the site.

7.3 Assessment methodology

Engagement

7.3.1 Vol 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 24 Table 7.3.1 below summarises the comments raised by consultees and how each comment has been addressed.

7.3.2 In addition to the consultation detailed below, the design at this site has been developed in light of ongoing consultation, which has been undertaken throughout the pre-submission phase, with consultees including English Heritage and the Royal Borough of Greenwich. Consultation has highlighted historic environment design considerations and helped to guide the direction of design development.

7.3.3 The need to integrate the new structures into the listed buildings, without damaging their significance, while providing the empty East Beam Engine House at Greenwich Pumping Station with an operational purpose, was the prime consideration in designing the interventions to the listed buildings. The design has also been developed to respect the setting of the Ashburnham Triangle Conservation Area, views to/from the conservation area and other local views. For example, the works would enable the palisade fencing to the north and north east of the listed building to be rationalised to improve the setting of the listed building and the listed Network Rail viaduct.

7.3.4 The desire to avoid locating site accommodation in the location of the listed coal sheds in the west of the site was also an important consideration. Both English Heritage and Royal Borough of Greenwich expressed a preference for not temporarily removing the listed coal sheds. Efforts to identify an alternative location for the site compound were successful, obviating the need to temporarily remove these structures.

Vol 24 Table 7.3.1 Historic environment – consultation response

Organisation and date	Comment	Response
Meeting with Royal Borough of Greenwich	RB Greenwich confirmed their view that the curtilage of the listed Pumping Station building was limited to its	Alterations to the fabric have been designed particularly carefully within the curtilage to

Organisation and date	Comment	Response
	footprint, the entrance podiums and the staircase to the west of the East Beam Engine House's northern entrance podium	minimise adverse effects
English Heritage Phase two consultation response (February 2012)	English Heritage is opposed to dismantling of Grade II listed coal sheds.	Temporary dismantling of the coal sheds is no longer proposed. The *CoCP* Part B (Section 12) includes measures to protect the sheds from accidental strike damage during construction.
	Further technical detail required on proposed alterations to engine house in order to facilitate introduction of ventilation equipment.	The design principles include detail on the proposed alterations to the Grade II listed building. Further detail is set out at para. 7.2.7 above.
	Mitigation should include improvement and enhancement to condition and setting of listed buildings.	This assessment concludes that a beneficial effect would result from bringing the Beam Engine House back into use along with sympathetic refurbishment.
	Notes proposal by London Borough (LB) of Lewisham for new conservation area on west side of Deptford Creek opposite the site.	The proposal for the conservation area is noted in this assessment.
	Buried terrain modelling of predicted archaeological deposits needed.	Mitigation measures are proposed in Section 7.8. These would be further informed by field evaluation. This could include a variety of techniques, such as geotechnical investigation, geoarchaeological deposit modelling,

Organisation and date	Comment	Response
		archaeological test pits and trial trenches.
English Heritage Section 48 publicity comments (October 2012)	English Heritage wishes it to be made clear that the beneficial impacts on the settings of the listed Beam Engine House, the wider Pumping Station and the railway viaduct are dependent on landscaping.	The assessment of effects on the setting of these assets takes into account the proposed landscaping as detailed in the design principles, which is for wild flower and grassland planting.
	English Heritage welcomes and strongly supports the amendment of proposals to avoid demolition of the Grade II listed coal sheds at Greenwich Pumping Station.	English Heritage concerns were noted and the development proposals subsequently modified to ensure that the coal sheds would be retained *in situ*.
	Assessment of effects should include impact of settlement due to construction works.	This section of the ES includes an assessment of ground movement effects at this site.
	English Heritage observes that the assessment would benefit from including a summary of the settlement impacts on the various heritage assets.	This section of the ES includes an assessment of ground movement effects at this site.
English Heritage consultation following the completion of damage assessment (ground movement) reports (June 2012)	EH requested confirmation as to why physical mitigation measures such as underpinning or grouting is not considered appropriate for Greenwich Pumping Station	The calculated movements of Greenwich Pumping station are similar to those that would be expected from the installation of intrusive mitigation measures themselves, such as compensation grouting or underpinning. Refurbishment and making good of the East Beam Engine House would be undertaken as part of the development in order to allow re-use of the structure. It is

Organisation and date	Comment	Response
		considered that it would be most appropriate to repair any cracks caused by ground movement as part of these refurbishment works.

Baseline

7.3.5 The baseline methodology follows the methodology described in Vol 2. It should be noted that whilst most 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. In terms of site-specific variations, the results of archaeological standing building recording carried out within the site have been incorporated in the baseline.

7.3.6 Baseline conditions for above-ground and buried heritage assets are described within a 350m-radius area around the centre point of the site, which is considered through professional judgement to be most appropriate to characterise the historic environment potential of the site. There are occasional references to assets beyond the baseline area, for example, potential Saxon settlements at Deptford Strand which lies 550m to the northwest of the site, and Deptford Bridge, 370m to the southwest of the site, which each contribute to current understanding of the site and its environs in the Saxon period.

7.3.7 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 Vol 20 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 350m radius baseline area. In addition, ‘Views of Heritage Value’ (VHV) considered important for understanding the historic character and setting of heritage assets have been identified where appropriate. These are drawn from the relevant conservation area appraisals and from professional judgement based on observation and understanding of historic context and architectural purpose and design.

7.3.8 A site visit was carried out in March 2011 during which building interiors were observed. A further site visit was carried out in January 2012 to identify assets for inclusion within the assessment of effects on setting.

Construction

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

7.3.10 In terms of physical effects on above ground or buried heritage 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, or in the case of ground movement, by the limit of the area in which ground movement is predicted to be 1mm or more.

7.3.11 In terms of effects on the historic character and setting of above-ground heritage assets, while there would be effects throughout the construction period the peak construction phase is Site Years 2-4, when the shaft would be under construction and cranes would be present at the site. This has therefore been used as the assessment phase 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 as described in para. 7.3.7.

7.3.12 Section 7.5 details the likely significant effects arising from the construction at the Greenwich Pumping Station site. The Deptford Church Street site could give rise to additional effects on the historic environment within the assessment area for this site and is therefore also considered in this assessment.

7.3.13 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. 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. Furthermore none of the schemes included in the site development schedule (Appendix N) would lead to physical changes in above ground or buried heritage assets within the Greenwich Pumping Station site. Therefore any changes to the surrounding baseline would not affect the assessment and are not detailed further within the construction base case.

7.3.14 The following developments from the site development schedule (Vol 24 Appendix N) have been considered as part of the construction base case for the assessment of effects on historic character, appearance and setting in the construction phase due to their proximity to the Thames Tideway Tunnel project site:

a. 43-81 Greenwich High Road, adjacent to the site

b. 83-87 Greenwich High Road, adjacent to the site

c. Greenwich Industrial Estate, adjacent to the site.

7.3.15 None of the other schemes listed in the development schedule (Vol 24 Appendix N) would give rise to a change in the baseline. This is due to their distance from the site and the presence of intervening buildings.

7.3.16 The Creekside Village East development on Copperas Street, 120m north of the site, would be under construction during the construction phase assessment years, and is therefore included in the cumulative effects assessment. All of the other schemes detailed in the development schedule would be completed and operational by the construction phase assessment years and so are not relevant to the assessment of cumulative effects.

7.3.17 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 project construction, would not lead to any change in the archaeological baseline and therefore no change in the assessment of effects on these assets.

Operation

7.3.18 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 assessments may differ to the historic environment assessments of the operational phase, despite the receptors being largely coincident. This is due to the different value / sensitivity that may be attributed to a receptor and also due to consideration of different factors when assessing the magnitude of change and significance of effect (the reasoning is explained in each assessment). The operational assessment area is as described in para. 7.3.7.

7.3.19 As stated in para. 7.3.12 the Deptford Church Street site could give rise to additional effects on the historic environment within the assessment area for this site and is therefore also considered in this assessment.

7.3.20 The following developments from the site development schedule (Vol 24 Appendix N) have been considered as part of the operational base case for the assessment of effects on historic character, appearance and setting in the operational phase due to their proximity to the Thames Tideway Tunnel project site:

a. 43-81 Greenwich High Road, adjacent to the site

b. 83-87 Greenwich High Road, adjacent to the site

c. Greenwich Industrial Estate (adjacent to the site)

d. Creekside Village East (120m north of the site).

7.3.21 None of the other schemes listed in the development schedule (Vol 24 Appendix N) would give rise to a change in the baseline. This is due to their distance from the site and the presence of intervening buildings.

7.3.22 As all of the schemes set out in the site development schedule (Vol 24 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. Therefore no assessment has been undertaken of cumulative effects on the historic character and setting of heritage assets in the operational phase.

7.3.23 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

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

Assumptions

7.3.25 The assessment of effects on buried heritage assets is based on the shaft and other below ground structures being located anywhere within the zones identified on the Site works parameter plan (see separate volume of figures - Section 1) for these structures. For this site the assessment is not sensitive to variations in location within these zones because the desk-based assessment has not located any buried heritage assets of high significance within the site, which would warrant preservation *in situ*.

7.3.26 A number of assumptions have been made regarding the likely depth of temporary construction works (eg, site strip, footings for plant and accommodation), based on professional knowledge of construction projects. Whilst the precise nature of construction effects on buried heritage would vary if the depths varied, the mitigation proposed to address any effects would remain as stated, as would the residual effects. These assumptions are detailed in Section 7.2.

7.3.27 The assessment of effects on the historic character and setting of above-ground heritage assets is similarly based on the 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 developments, which have large gaps between them.

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

Limitations

7.3.29 A limitation of the assessment is that no intrusive archaeological investigation has been carried out on the site in the past, although several investigations have been carried out within the baseline area around the site. Nevertheless the assessment is considered to be robust and in accordance with best practice.

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 350m-radius baseline area

b. a description of statutorily designated assets within the site and baseline area, and locally designated assets and known burial grounds are included, where relevant, as described in Volume 2

c. a description of the site location, topography and geology

d. a summary of past archaeological investigation, providing an indication of how well the area is understood archaeologically

e. a chronological summary of the archaeological and historical background of the site and its environs

f. a statement of significance for buried heritage assets, taking account of factors affecting survival

g. a statement of significance for above-ground assets within and around the site, describing the features which contribute to their significance, including historic character, appearance and setting.

Current baseline

Historic environment features

7.4.2 The historic environment features map (Vol 24 Figure 7.4.1, see separate volume of figures) shows the location of known above-ground and buried historic environment features within the 350m-radius baseline area, compiled from the baseline sources set out in the methodology in Vol 2. These have been allocated a unique historic environment assessment reference number (HEA 1, 2, etc), which are listed in the gazetteer in Vol

24 Appendix E.1. 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 and extends beyond the 350m area where appropriate, with assets described in the 'Statement of significance: above-ground heritage assets' later in this section.

Designated assets

International and national designations

7.4.3 The site contains a Grade II listed 19th–20th century pumping station, consisting of two beam engine houses, flanking a boiler house, and an early 20th century western extension (HEA 1A) in the centre of the site, and two separate Grade II listed 19th century coal sheds in the southwestern part of the site (HEA 1B and HEA 1C). These date to the early 1860s and were designed by John Aird and Sons for the Metropolitan Board of Works to form part of the Bazalgette scheme to improve London's sewers. The East and West Beam Engine Houses were built in an Italianate style, linked by a central boiler house. The listing includes the stone steps on the northern side of the East Beam Engine House, iron railings and entrance platform and the 1905 extension to the Western Beam Engine House, which was built to match the style of the 1865 building.

7.4.4 The Grade II listed 19th century London to Greenwich brick-built railway viaduct crosses the central part of the site (HEA 1F) with the lifting bridge structure over Deptford Creek at its western end. The section of the railway viaduct which falls within the site is known as Hart's Wharf Viaduct.

7.4.5 Grade II listed buildings located within the immediate vicinity of the site (ie, within a 100m-radius) include 98-104 Greenwich High Road (HEA 4), and 165–167 Greenwich High Road (HEA 13).

7.4.6 There are no internationally designated heritage assets in the vicinity of the site.

Local authority designations

7.4.7 The site lies to the north of the Ashburnham Triangle Conservation Area and just outside of it. The LB of Lewisham undertook a consultation exercise ending in January 2012 about the possible designation of a conservation area on the west side of Deptford Creek opposite the development site. This was implemented following a favourable public response on 9th May 2012.

7.4.8 The site lies within an extensive area of archaeological potential (AAP), as designated by the Royal Borough (RB) of Greenwich. This covers Greenwich Park (part of a World Heritage Site), Greenwich town centre historic settlement, and the Thames foreshore, all of which lie outside the baseline area, and Deptford Creek, which lies within the baseline area, adjacent to the western edge of the site.

7.4.9 Several locally listed buildings lie within the site baseline area, including 1–10 Ashburnham Grove (HEA 23), 10–11 Ashburnham Place (HEA 24), Nos.4 and 6, 8-24 (even) Burgos Grove (HEA 25), Devonshire Drive Baptist Church (HEA 27), Holy Trinity Church, Devonshire Drive (HEA28), and 135 Greenwich High Road (HEA 31). There are further locally listed buildings at 7-13 Egerton Drive, 17-32 Egerton Drive, 43 and 45 Devonshire Drive. With the exception of 135 Greenwich High Road all lie within the Ashburnham Triangle Conservation Area.

7.4.10 All these buildings and many more locally listed buildings within the Ashburnham Triangle Conservation Area outside the assessment area for the assessment of effects on the character and setting of the conservation area (there are 210 locally listed buildings in total) have, individually, no visual relationship with the site due to their distance from the site or the presence of intervening structures and have not been assessed further, individually. However, this assessment does have regard to the effect on the character and setting of the Ashburnham Triangle Conservation Area as a heritage asset.

7.4.11 The effect on135 Greenwich High Road belongs within an assessment of the effect on other above-ground heritage assets on Greenwich High Road. However, due to the presence of intervening structures around the site or their distance from the site, it has not been necessary to assess further the effect on any of these assets.

Known burial grounds

7.4.12 There are no known burial grounds within the site or adjacent to it. The nearest known burial ground to the site lies approximately 60m to the south, but does not extend into the site (HEA 19).

Site location, topography and geology

7.4.13 The site lies along the eastern bank of Deptford Creek, 300m to the south of the River Thames. The topography of the site varies. The northwest corner lies at 105.0m ATD (above Tunnel Datum) and slopes down to 103.2m ATD at the eastern edge. To the south, the site rises up from 103.5m ATD in the southwest corner to 105.7m ATD in the southeast corner. The foreshore of Deptford Creek along the western edge of the site lies at 101.7m ATD.

7.4.14 The site is located on the eastern side of the floodplain of the Ravensbourne River (known locally as Deptford Creek). The western part of the site overlies floodplain alluvium over Shepperton gravels. The eastern part of the site overlies the Kempton Park Gravel terrace on the valley side. Beyond the eastern site boundary, natural bedrock is overlain by soliflucted silt and gravel Head deposits (solifluction is hillwash which can seal ancient land surfaces).

7.4.15 Boreholes within the eastern part of the site revealed variable depths of made ground over gravel, between 3.0–5.0m and 1.2m thick in places. Some alluvial deposits were noted above the gravel. The surface of the Kempton Park Gravel of the river terrace exists as isolated outcrops at the edge of the floodplain, at around 103.5m ATD.

7.4.16 Borehole logs within the western part of the site recorded the surface of Shepperton Gravel below the floodplain at 97.0m to 99.2 ATD, although it is probably deeper in incised channel areas. Within the central part of the site the gravel surface is likely to be irregular where it slopes and slumps between the river terrace and the floodplain.

7.4.17 A monitored geotechnical borehole within the southwest of the site recorded the surface of the Shepperton Gravel below alluvial deposits at 99.2m ATD. Alluvial deposits survive above the gravel with approximately 1.0m of clayey peat overlain by approximately 0.5m of silty clay from approximately 100m ATD. The alluvial deposits were sealed by 3.0m of made ground.

7.4.18 The alluvium blankets both the Shepperton Gravel of the floodplain and the Kempton Park Gravel of the river terrace, becoming thicker from east to west, into the floodplain. The full extent of alluvium within the site is uncertain. The site topography and geology is discussed in more detail in Vol 24 Appendix E.2.

Past archaeological investigations

7.4.19 Eight archaeological investigations have been carried out within the baseline area in the past, all of which recorded assets dating to the 18th and 20th centuries. No earlier assets were uncovered. In 2002, an archaeological foreshore survey (HEA 1E) along Deptford Creek, in the northern part of the site, recorded various 19th century structures including timber river walls and revetments, masonry riverbed lining; a dock or inlet; barge-bed revetments; masonry and timber splash aprons for the sewage pumping station outfall pipe; a masonry and timber drain; the rail bridge; and a line of timber uprights which may be remnants of the river wall predating the 18th century. Further details of past archaeological investigations carried out within the site and baseline area are included in Vol 24 Appendix E.3.

Archaeological and historical background of the site

7.4.20 The following section presents a chronological summary of the archaeological and historical background of the site. Further detail is included in Vol 24 Appendix E.4.

7.4.21 The Ravensbourne would have been an important feature in the prehistoric period (700,000 BC–AD 43) as, like other rivers, it served as a route through the forested landscape and was a source of rich natural resources. In the later prehistoric period, the nearby high ground of the river terrace in this location could have made it a focus for settlement or occupation, whilst the floodplain of the creek would have become increasingly marshy. The majority of the site would have been prone to flooding. There are no known prehistoric features or finds within the baseline area, although it is possible that such remains might be sealed within the alluvium.

7.4.22 The likely projection of the Roman (AD 43–410) road Watling Street, the main road through this area, probably followed modern New Cross Road, 330m to the south of the site (the Greater London Historic Environment Record records a location 40m to the north of the site (HEA 7), but this is likely to be an error). The road crossed Deptford Creek at Deptford Broadway, near the bridge over it 330m to the southwest, a likely location for settlement. A portion of Roman tessellated pavement and brickwork was excavated here in 1866, and a nearby archaeological excavation uncovered fragments of Roman pottery. No evidence of Roman occupation has been recorded within the baseline area itself. During this period the site lay on the eastern bank of Deptford Creek and would have been seasonally flooded as a result of rising sea levels. The place name of Deptford itself is Anglo-Saxon (AD 410–1066) in origin, referring to a deep ford crossing the River Ravensbourne. The old Roman road is likely to have continued in use. Two Saxon settlement centres have been suggested at Deptford Strand, in the area of St Nicholas' Church at Deptford Green, 550m to the northwest of the site, and in the vicinity of Deptford Bridge 370m to the southwest of the site. Both settlements continued to flourish in the later medieval period (AD 1066–1485), and the GLHER (HEA 17) suggests that it stretched along the western, opposite, bank of Deptford Creek to within 100m of the site, although a 17th century map by John Evelyn shows settlement further to the north and west, and a greater distance from it.

7.4.23 During the later medieval period, the site would have still been located outside of the main areas of occupation. Parts or the entire site would have been seasonally flooded and it was probably used for rough pasture and the grazing of livestock. Attempts may have been made to drain and reclaim the area. A series of timber stakes recorded 200m to the west of the site (HEA 6) may have been part of a structure for such a purpose, although they are yet to be firmly dated.

7.4.24 During the post-medieval period (AD 1485–present), Deptford became the last stopping place on the Dover Road before London. In the mid-18th century the site comprised reclaimed marshland, market gardens and properties fronting onto the road which runs along the southeastern edge of the site, later Greenwich Road. By the 19th century a drainage ditch crossed the site, parallel to Deptford Creek.

7.4.25 Chapel Place was a short street which has now become the access on to the site from its southeastern corner. It may have acquired its name from an earlier chapel in the area which originated as a wooden barn 'on the north side of Greenwich Road, now Greenwich High Road' in around 1750. The exact location of this early chapel is uncertain but it probably lay just outside of the site to the east of Chapel Place. The reluctance of the Anglican Church to conduct burial funerary services over non-conformers led to the growth of burial grounds attached to nonconformist meeting houses during the 18th century. No historic maps show a burial ground on the site but it is conceivable that burials took place within or around the early chapel before it was replaced by the Congregational Chapel outside of the site on the opposite, southern, side of Greenwich High Road between 1799 and 1801. Mrs Basil Holmes's survey of burial grounds of 1896 does not record one on the site but refers to the burial-ground next to the Congregational Chapel as operating from c. 1800.

7.4.26 Between 1859 and 1862, Deptford (Greenwich) Pumping Station was constructed on the site. The Beam Engine Houses (HEA 1A), central boiler house that connects them and two large coal sheds (HEA 1B and 1C) are still extant and are Grade II listed. In 1905, the Beam Engine

House was extended, and around this time the terraced houses which lay along the southern edge of the site had been demolished.

7.4.27 A cooling basin (HEA 1D), in the form of a large concrete tank, divided centrally, north-south, into two chambers, was built to the north of the main buildings, probably in the early 20th century. It is no longer visible and is believed to survive at least in part underground.

7.4.28 During World War II the two coal sheds suffered serious but repairable damage.

7.4.29 The Phoenix Wharf currently occupies the northern section of the site. The Docklands Light Railway (DLR) was constructed in the late 1990s and cuts across the central part of the site. The southern part of the site contains the Greenwich Pumping Station buildings. The two coal sheds have been used for storage and the southernmost of the two has modern cement block structures within it.

Statement of significance: buried heritage assets on the site

Introduction

7.4.30 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, eg, building foundations), identified primarily from historic maps, the site walkover survey, and information on the likely depth of deposits.

7.4.31 In accordance with the National Policy Statement for Waste Water (Defra, 2012)[1], National Planning Policy Framework (DCLG, 2012)[2] and PPS5 Planning Practice Guide (DCLG, 2010)[3], (which remains extant), 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

7.4.32 Archaeological survival potential across the site is likely to vary. Remains within and beneath any deep alluvial deposits, and at the alluvial/gravel interface, (ie, possible palaeoenvironmental and prehistoric remains) generally have a greater potential for survival, whilst later remains will have seen disturbance from building development from the mid to late 19th century onwards, which is likely to result in localised rather than extensive survival.

7.4.33 Cooling tanks in the central part of the site (north of the pumping station) are thought to have a base at a depth of 4.0mbgl. Their construction would have removed any archaeological remains from within their footprint to this depth, although early deeply buried remains might survive intact beneath, given that alluvium has been noted extending down to approximately 6.0mbgl close to Deptford Creek.

7.4.34 The construction of the DLR Lewisham extension viaduct in the 1990s would have removed any archaeological remains within the footprint of its foundations.

7.4.35 The Beam Engine Houses, including the 1905 extension, have large subterranean areas extending to a depth of several metres. These will have completely removed any earlier archaeological remains from within their footprint, although early deeply buried remains might survive intact beneath given the depth of alluvium. The remains of the engine houses would be of archaeological interest.

7.4.36 Numerous service trenches (eg, sewer, gas, cables etc) cross the site. The deepest service trenches are the East Greenwich Branch Sewer which crosses the site on a southwest/northeast alignment (which is up to 6.5m deep) and the Southern Low Level Sewer No 1, which lies in the northwestern part of the site (which is up to 7.0m deep), which will have removed the majority of any archaeological deposits locally. Where shallow services of approximately 1.0–2.0mbgl are present, archaeological remains could potentially survive beneath this truncation.

7.4.37 The existing buildings and former terraced housing on the southern part of the site would have been constructed on strip or pad foundations. These are likely to have removed any archaeological remains from within their footprint, although there is likely to be some archaeological survival between and beneath individual foundations. Any cellars beneath the terraced houses would have partially or completely removed any earlier archaeological remains within the footprint of each cellar.

Asset potential and significance

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

Palaeoenvironmental

7.4.39 The site has a high potential to contain palaeoenvironmental remains. These geological deposits have the potential to hold a record of environmental change and the evolving floodplain geomorphology stretching back to the Late Glacial period. Any peat deposits have the potential to preserve information that could be utilised to reconstruct the palaeoecology of the floodplain and environments within which prehistoric occupation occurred. Any fluvial and estuarine deposits would also have the potential to preserve palaeoenvironmental remains which can be used to reconstruct past fluvial regimes and indicate the onset of tidal inundations and the transition to an estuarine river environment. Such remains 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

7.4.40 The site has low potential for archaeological remains dating to the prehistoric period. There are no known prehistoric features or finds within the baseline area. The majority of the site overlies alluvial deposits suggesting that the site probably lay within the Deptford Creek or its floodplain during this period, and so would not have been a first choice for permanent occupation. Marshland activity may have taken place, but no evidence of prehistoric timber trackways, for example, has been found within the baseline area. Isolated artefacts, if present, would be of low asset significance, derived from their evidential value.

Roman

7.4.41 The site has low potential for archaeological remains dating to the Roman period. It is thought that there were at least two areas of Roman occupation at Deptford, the nearest of which lay approximately 330m to the southwest of the site, near the modern Deptford Bridge Station. No evidence of Roman activity or occupation has been recorded within the baseline area, and in all likelihood the site lay some distance from the main settlements in a rural area along the creek. It would probably have been prone to flooding and may have been used for pasture. Isolated Roman artefacts would be of low asset significance, derived from their evidential value.

Early medieval

7.4.42 The site has low potential for archaeological remains dating to the early medieval period. The site would have lain on the eastern bank of the Deptford Creek in marshes beyond the main settlement at the southern end of Deptford High Street approximately 330m to the southwest of the site. Isolated early medieval artefacts would be of low significance, derived from their evidential and historical value.

Later medieval

7.4.43 The site has low potential for archaeological remains dating to the later medieval period. It is likely that during this period the site still lay outside the main local settlements in marshy or seasonally inundated land. Later medieval riverside features (eg, revetments, wharves etc) might have been built along the Deptford Creek riverbank but no remains which are demonstrably of this date have been recorded during surveys of the Creek and no works are proposed which would impact on the area of the site where such remains would be likely to be found. Agricultural ditches and evidence of reclamation, and isolated artefacts, would be of low significance, derived from their evidential and historical value.

Post-medieval

7.4.44 The site has a high potential for archaeological remains dating to the post-medieval period. The main potential is for footings of buildings shown on historic maps from the mid-18th century onwards, and for the buried remains of Victorian sewer infrastructure. By the mid 18th century most of the site was open fields, other than several buildings in the southern part, fronting onto the main road. One of the buildings may have been a barn that was used as a chapel and referred to in documentary sources. From the 19th century, terraced houses were built in the southern part of the site. The buried remains of these buildings (eg, footings, cellars) would be of low asset significance based on their evidential and historical value. Evidence of post-medieval agriculture and reclamation for which there is low potential would be of low significance. It is conceivable that there may have been burials associated with the chapel, if this had been present before it was rebuilt as the Congregational Chapel in c. 1800 beyond the site on the opposite side of Greenwich High Road. Burials, if present (low potential), would be of high asset significance.

7.4.45 The site contains the meeting point of four of the original Bazalgette sewer lines, the Southern Low Level Sewers Numbers 1 and 2 and the Southern High Level Sewer and the eastward leading sewer to Crossness, the Southern Outfall Sewer, into which the combined contents of the first three were directed. Buried remains of these and other sewage infrastructure, including the cooling tanks, a penstock chamber, a pumping chamber, well and valve chamber and the interconnecting pipes between the basin and the Beam Engine House, are considered heritage assets of medium significance, derived from their historical and evidential value.

Statement of significance: above-ground heritage assets

Introduction

7.4.46 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 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.

7.4.47 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 24 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 baseline area whose settings would be significantly adversely affected by the proposed development.

Within the site

Greenwich Pumping Station

7.4.48 The site contains four Grade II listed buildings. Three are associated with Bazalgette's Greenwich Pumping Station, which was built from 1859 and was operational by 1865. These comprise the East and West Beam Engine Houses, linked by a boiler house (HEA 1A) and two associated and separately listed coal sheds (HEA 1B, 1C), located in the southern half of the site. One listed building (HEA 1F) is a railway viaduct that crosses the centre of the site.

7.4.49 The East and West Beam Engine Houses of the pumping station are built in an Italianate style (HEA 1A) (Vol 24 Appendix E.5, Plate E.9). The central boiler house and the West Beam Engine House, along with its 1905 annexe, are currently occupied by Thames Water and are still used as a pumping station. The East Beam Engine House is unoccupied and the machinery has been removed, although some internal features of interest survive (Vol 24 Appendix E.5, Plate E.11). Both beam engine houses have large subterranean pumping chambers, which are of heritage interest in their own right. The listing includes the stone steps on the northwestern side of the building, the surviving iron railings and entrance platform (Vol 24 Appendix E.5, Plate E.12), and the 1905 extension, which was built to match the Italianate style of the 1860s building. The main pumping station building is an asset of high significance, derived from its evidential, historical and aesthetic value.

7.4.50 To the south of the pumping station are two separate coal sheds (HEA 1B and HEA 1C). The northern coal shed is free of any recent structures and the original cobbled surface survives (Vol 24 Appendix E.5, Plate E.10). Coal was unloaded from Deptford Creek at Greenwich Road Wharf and stored in the adjacent coal sheds. From there it was loaded on to trolleys, running along rails complete with turn tables and pushed, probably manually, to feed coal into the central boiler house. The rails and turntables may survive in places beneath the modern surface. Both coal sheds are heritage assets of high significance derived from their evidential and historical value.

7.4.51 The setting of the Greenwich Pumping Station is very tightly defined. To the north, its setting is defined by the line of the Grade II Listed London and Greenwich Railway Viaduct (HEA 3), views to which have been curtailed by the presence of the DLR viaduct, which detracts from the setting. To the west and northwest its setting is defined by the line of Deptford Creek, whilst to the southwest, south and east it is defined by the buildings fronting onto Greenwich High Road and Norman Road. The separately listed coal sheds (HEA 1B, 1C) adjacent to the structure also form part of the setting of the pumping station. The site is largely enclosed by surrounding buildings; views to and from the pumping station are limited to those along the internal entrance road from Greenwich High Road, illustrated in View of Heritage Value 1 (see Vol 24 Figure 7.4.2, separate volume of figures). The rear of the building can also be seen from the works entrance on Norman Street, shown on Vol 24 Plate 7.4.1. There is no visual relationship with the adjacent Ashburnham Triangle Conservation Area, although there is a relationship with the eastern edge of Creekside Conservation Area. There is no visual relationship with any other significant heritage assets. The site itself is characterised by existing operating works, storage compounds and security fencing, which detract from the historic character of the site and setting of the Greenwich Pumping Station.

7.4.52 Given the contained, inward looking character of the site, the functional use of the surrounding grounds and intervening presence of the DLR viaduct, the contribution of setting to the significance of the Greenwich Pumping Station is low.

Vol 24 Plate 7.4.1 Historic environment – view south within the site towards the northwest frontage of Greenwich Pumping Station

London and Greenwich Railway

7.4.53 The London and Greenwich Railway was London's first passenger railway, opening in 1836 and originally running from Spa Road Bermondsey to Deptford with the extension to Greenwich opening in 1838. The brick-built viaduct and the lifting bridge structure over Deptford Creek still stand, and are in good condition (HEA 1F) (Vol 24 Appendix E.5, Plate E.14). The listed Network Rail viaduct runs across the northern central part of the site, continuing westward on the opposite side of Deptford Creek (under a separate listing entry; the bridge itself is not covered by either listing). The section of viaduct which runs through the site is known as Hart's Wharf viaduct. The whole section from Greenwich to Deptford Creek is a Grade II listed structure and is a heritage asset of high significance, derived from its evidential, historical and aesthetic value.

7.4.54 The setting of the viaduct is largely defined by modern light industrial units either side of the railway corridor. Views to the site from the viaduct are restricted by the intervening presence of the DLR viaduct which passes between the pumping station and the 1838 railway viaduct. The contribution of setting to the significance of the London and Greenwich Railway Viaduct is low.

Within the assessment area

Asburnham Triangle Conservation Area

7.4.55 The Ashburnham Triangle Conservation area, designated by the RB of Greenwich, lies directly to the south of the site with its northwestern boundary beginning on the opposite side of Greenwich High Road. The conservation area is named after the Ashburnham Family who owned and developed much of the area in the early-mid 19th century. It includes a rich variety of residential buildings mainly from the early and mid-19th century, with some earlier buildings surviving. There are 26 statutorily listed and 210 locally listed buildings within its boundary. The conservation area is a heritage asset of high significance.

7.4.56 The northern boundary Ashburnham Triangle Conservation Area is defined by the line of Greenwich High Road, which is characterised by an uneven frontage of 19th century institutional buildings – notably the former Greenwich Town Hall and the Miller General Hospital and Dispensary (HEA 16, 18) – and domestic dwellings, including the Grade II listed Nos. 98-104 Greenwich Road (HEA 4) and the Grade II listed buildings at the northeastern end of the Greenwich Road (HEA 13, 14). There is a locally listed building at 135 Greenwich High Road (HEA 31). There are distinct views along the Greenwich High Road in both directions, as illustrated in View of Heritage Value 2 (see Vol 24 Figure 7.4.2, separate volume of figures). The rest of the Ashburnham Triangle Conservation Area is characterised by Georgian and Victorian terraced housing. The area is largely inward-looking, with little open space and no significant views towards the site. Setting therefore makes only a moderate contribution to the significance of the conservation area. The Thames Tideway Tunnel site makes a negligible contribution to the setting of the conservation area.

Creekside Conservation Area

7.4.57 Creekside Conservation Area, a heritage asset of high significance, has two distinct characters. The listed London and Greenwich railway viaduct bisects the conservation area from east to west. The eastern part of the area to the south, nearest to the site, is characterised by a relatively intact industrial and warehouse area, the only surviving industrial area of some coherence on Deptford Creek. The area to the north, and the western part of the southern portion of the conservation area, is occupied by the Crossfield Estate, a typical 1930s London County Council estate that became a centre of the radical arts music scene in the 1970s and 1980s. The part of the conservation area facing the creek consists of industrial and warehouse buildings with wharf frontages, consisting of the Faircharm Trading Estate and Harold Wharf, which front onto Creekside. With the Pumping Station the character of this small area of the Creek is industrial, with mid 19th to early 20th century buildings.

LESC substation

7.4.58 Abutting the southwestern edge of the site boundary is a disused London Electric Supply Corporation (LESC) Ltd electricity substation (HEA 32) (Vol 24 Appendix E.5 Plate E.13). The LESC was founded in 1888 and built Britain's first large scale electrical power station (demolished in the 1960s) at the mouth of Deptford Creek to the north of Greenwich Pumping Station beyond the site. The engineer was the prominent inventor and pioneer of the alternating current, Sebastian Ziani de Ferranti. The LESC therefore has a strong historical link to the Deptford Creek area, although the substation building on the boundary of the site appears to date from the early-mid 20th century. Due to its evidential and historical value, it is an asset of medium significance. The substation is located on Greenwich High Road and is separated from the site by the presence of intervening buildings. The contribution of setting to its significance is low.

Brick chimney

7.4.59 Within the Thames Water compound, outside the site boundary to the southeast of the pumping station, is a brick built chimney (HEA 34). It is relatively small in height for an industrial chimney and is overgrown with foliage (Vol 24 Appendix E.5 Plate E.15). Its exact function and date are unclear, but is considered to be of medium heritage significance due to its historical value, its likely age and its probable association with the listed pumping station buildings nearby, within the site. The chimney is separated from the site by the presence of intervening buildings. The contribution of setting to its significance is low.

Construction base case

7.4.60 As described in para. 7.3.14, no developments identified within the site development schedule (Vol 24 Appendix N) would lead to any loss of or change in the buried heritage assets within the site. The base case against which construction effects on buried heritage assets within the site are assessed is therefore the same as the baseline.

7.4.61 For above ground heritage assets none of the schemes identified in Vol 24 Appendix N would cause ground movement that would adversely affect the heritage assets that are also within the area of ground movement generated by the construction works at the Greenwich Pumping Station site. Therefore the base case for this aspect of the assessment is also as per the baseline.

7.4.62 Three schemes identified from the development schedule (Vol 24 Appendix N) have been considered in terms of the base case in Site Years 2-4 of construction for the assessment of effects on setting:

a. 43-81 Greenwich High Road, adjacent to the site

b. 83-87 Greenwich High Road, adjacent to the site

c. Greenwich Industrial Estate (adjacent to the site).

7.4.63 These schemes would in-fill vacant plots along the northern side of Greenwich High Road, further enclosing the site. The schemes would not materially alter the setting of Greenwich Pumping Station or intervene in recognised views. The base case for the construction phase would therefore remain unchanged from the baseline.

Operational base case

7.4.64 As detailed in para. 7.4.63, the presence of the development schemes along the Greenwich High Road would not lead to a change in the baseline. The base case for the operational phase would therefore remain unchanged from the baseline.

7.5 Construction effects assessment

Buried heritage assets

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

Site set-up and demolition

7.5.2 Works carried out as part of the initial site set-up, including preliminary site stripping and demolition, the installation of site fencing and welfare facilities and service diversions would have a localised impact on archaeological remains. This would locally reduce the significance of the assets to negligible. The environmental effect would vary depending upon the magnitude of impact and the heritage significance of the assets removed:

a. There is a low potential for later medieval drainage and reclamation, of low asset significance. The localised removal of these remains would comprise a medium magnitude of impact and would result in a minor adverse effect.

b. There is a high potential for subterranean mid/late 19th century Bazalgette sewers, to which localised alterations would comprise a low magnitude of impact and would result in a minor adverse effect.

c. There is a high potential for buried remains of mid/late 19th and early 20th century pumping station infrastructure, including known cooling tanks, chambers and associated pipework selected for demolition, of medium asset significance. The localised removal would comprise a high magnitude of impact and would result in a moderate adverse effect.

d. There is a high potential for buried remains (footings, basements, cellars) of post-medieval buildings, including a possible barn used as a chapel, of low asset significance. The localised removal of remains, a medium magnitude of impact, would result in a minor adverse effect. Burials associated with the chapel, if present (low potential), would be of high significance. Any impact on human remains would be a major adverse effect.

e. There is a high potential for post-medieval agricultural features and reclamation, of negligible asset significance, the removal of which would constitute a negligible adverse effect.

Construction of the CSO drop shaft

7.5.3 The large diameter CSO drop shaft would remove all archaeological remains within its footprint. The shaft would be located in the area of the early 20th century cooling tanks. These would have already removed any archaeological remains. However, there is potential for deeper, earlier, archaeological remains to survive beneath them.

7.5.4 The magnitude of impact of the shaft construction would be high. The environmental effects would comprise the following:

a. There is a high potential for palaeoenvironmental remains of low to medium significance. Such remains might survive beneath the cooling tank foundations. The removal of such remains would constitute a minor adverse effect.

b. There is a low potential for isolated prehistoric artefacts, of low significance, beneath the cooling tank foundations. Their removal would constitute a minor adverse effect.

c. There are buried remains of the early 20th century cooling tanks, chambers and associated pipework, of medium asset significance. Their localised removal would comprise a high magnitude of impact and would result in a moderate adverse effect.

Construction of the interception and valve chambers

7.5.5 Within the footprint of the new interception and valve chambers any archaeological remains surviving above the formation level of these works would be removed, reducing their significance to negligible. Archaeological remains in this area will have already been severely truncated by existing buried pumping station infrastructure. However, the magnitude of impact on any remaining archaeology would be high. The environmental effects would comprise the following:

a. There is a high potential for palaeoenvironmental remains of low to medium significance. The removal of such remains would constitute a minor adverse effect.

b. There is a low potential for isolated prehistoric artefacts, of low significance. The removal of such would constitute a minor adverse effect.

c. There is a low potential for isolated Roman artefacts, of low significance. The removal of such would constitute a minor adverse effect.

d. There is a low potential for isolated early medieval artefacts, of low significance. The removal of such would constitute a minor adverse effect.

e. There is a low potential for later medieval agriculture and reclamation, of low asset significance. The removal of such remains would comprise a minor adverse effect.

f. Following the localised removal at site set-up, any surviving remains of mid/late 19th and early 20th century pumping station infrastructure, including chambers and associated pipework beside the Beam Engine House, of medium asset significance, would be removed within the footprint of the interception and valve chambers. This would comprise a moderate magnitude of impact and would result in a moderate adverse effect.

g. There is a high potential within the area of impact for surviving post-medieval agricultural features and reclamation, of negligible asset significance, the removal of which would constitute a negligible adverse effect.

Above-ground heritage assets

Physical effects on above-ground heritage assets

7.5.6 The disused Grade II listed East Beam Engine House (HEA 1A) would be used to house ventilation structures, with a permanent ventilation duct connecting the CSO drop shaft to the ventilation outlets. The proposed modifications, as outlined in para.7.2.7 would have a localised impact consisting of small-scale modifications to the fabric of low magnitude. Given the high significance of the asset, this would constitute a **moderate adverse** effect.

7.5.7 The East and West Beam Engine Houses and London and Greenwich railway viaduct, all Grade II listed, are within the zone of assessment (where ground movement of 1mm or more is predicted) for ground movement resulting from the proposed works.

7.5.8 The East and West Beam Engine Houses would be subject to ground movement consisting of 15mm to 34mm of settlement in the area of the East Beam Engine House, dissipating across the remainder of the building to 1mm at the West Beam Engine House. The greatest movement would be expected to the north of the East Beam Engine House, in the area of the proposed interception chamber and connection culvert, with differential settlement of up to 20mm along the south western façade of the East Beam Engine House. The damage assessment categorises this building as having a moderate damage risk, concentrated at the East Beam Engine House, with cracking typically of up to 5-15mm wide predicted. However, this would not have a substantially detrimental effect on the significance of the listed building, as the wall finishes are plain brickwork, which can accommodate some movement and can be repaired and therefore the magnitude of change is considered to be low. There would be a **moderate adverse** effect on this asset.

7.5.9 The listed London and Greenwich railway viaduct would experience settlement to a maximum of 4mm, with minimal differential ground movement resulting from the proposed works. The damage assessment categorises this asset as having a predicted damage risk category of negligible, typically resulting in hairline cracks of a maximum of 0.1mm wide. The magnitude of change to this asset is considered to be negligible, and therefore there would be a **minor adverse** effect on the significance of the viaduct.

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

7.5.10 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

Setting of Greenwich Pumping Station

7.5.11 The construction works would only slightly detract from the setting of the Greenwich Pumping Station because of the utilitarian functions carried out at the site already mean equipment is frequently present on site. The existing (albeit limited) views to the pumping station along the access road off Greenwich High Road and works entrance off Norman Road would however be restricted by the presence of hoarding. Given the high significance of the asset and low magnitude of change, this would result in a **minor adverse** effect.

Setting of London and Greenwich Railway viaduct

7.5.12 The area to the north of the viaduct would be used for excavated material storage and handling, whilst the area to the south would be occupied by workshops and storage areas as well as construction plant. As the setting of the structure is very restricted, the magnitude of change would be low. Given the low contribution of setting to the significance of the asset and the low magnitude of change, the construction phase would have a **minor adverse** effect on the setting of the London and Greenwich Railway viaduct.

Setting of Ashburnham Triangle Conservation Area

7.5.13 The construction works would largely be screened from the setting of the Ashburnham Triangle Conservation Area by the presence of intervening buildings and vegetation. Hoardings would also limit views of construction activity (offices, welfare and parking) within the area of the existing coal sheds. The presence of cranes would be visible from Greenwich High Road and from parts of Ashburnham Triangle Conservation Area. Given the high significance of the conservation area and low magnitude of change, this would result in a **minor adverse** effect on the setting of the Ashburnham Triangle Conservation Area.

Setting of Deptford Creekside Conservation Area

7.5.14 The construction works would be visible from the Creekside industrial and warehouse buildings, although not from the Crossfield Estate, where the magnitude of change would be negligible. They would detract little from the setting of the nearest part of the conservation area, which is fairly robust and industrial in character. Cranes and construction activity would not be out of place in an industrial setting. The magnitude of change in relation of the setting of the Deptford Creekside Conservation Area, an asset of high significance, would be low overall from the works at Greenwich Pumping Station. The construction works at Deptford Church Street would affect the western part of the conservation area, and specifically the area of the Crossfield Estate to the north of the railway viaduct, although it would not affect the industrial south eastern part of the Conservation Area. The magnitude of change to the north western part of the conservation area from the Deptford Church Street construction works would be low. The railway viaduct would provide a visual barrier between the Deptford Church Street site and the industrial buildings in the south east of the conservation area affected by the Greenwich Pumping Station works.

7.5.15 Overall the effect on the Creekside Conservation Area would be **minor adverse**.

Sensitivity test for programme delay

7.5.16 In the event that the programme for the Thames Tideway Tunnel project is delayed by approximately a year, a greater proportion of the Creekside Village East development would be built out and occupied with a correspondingly reduced level of construction activity. This would not, however, materially change the assessment findings reported above.

7.6 Operational effects assessment

Physical effects on above-ground assets

7.6.1 The sensitive alterations to the East Beam Engine House, which would be complimentary and consistent with the original function of the building, would give the building a viable use and help ensure its survival and upkeep, counteracting any potential for decay or dereliction from disuse. Overall this is considered to be a **moderate beneficial** effect.

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

Setting of Greenwich Pumping Station

7.6.2 The introduction of areas of new planting and wildflower meadow would enhance the setting of the Greenwich Pumping Station, allowing it to be better appreciated as an example of 19th century public utility architecture. Given the high significance of the asset, the low magnitude of change would have a **minor beneficial** effect on the setting of Greenwich Pumping Station.

Setting of London and Greenwich Railway viaduct

7.6.3 By enhancing the landscaping to the fore of the pumping station, the operational proposed development would improve the immediate setting of the viaduct to both the north and south. Given the high significance of the asset, the low magnitude of change of the proposed development would have a **minor beneficial** effect on the setting of London and Greenwich Railway viaduct.

Setting of Ashburnham Triangle Conservation Area

7.6.4 The operational above ground structures would be primarily housed within the existing pumping station building, with development outside the pumping station being limited in scale (the shaft would be elevated above existing ground levels by approximately 1m) and there would be no operational lighting. Given the limited scale of development, it would be screened from Greenwich High Road and the Ashburnham Triangle

Conservation Area by the presence of intervening buildings and vegetation. The magnitude of change would be negligible, resulting in a **minor beneficial** effect on the conservation area.

Setting of Deptford Creekside Conservation Area

7.6.5 The above ground operational structures outside the pumping station building would be limited in scale (the shaft would be elevated above existing ground levels by approximately 1m) and there would be no operational lighting. Although it would be visible from across Deptford Creek, the improvement to the setting of the listed building would have a negligible beneficial change to the setting of the Conservation Area, which would result in a **minor beneficial** effect.

Sensitivity test for programme delay

7.6.6 In the event that the programme for the Thames Tideway Tunnel project is delayed by approximately a year, all the relevant schemes identified in the development schedule would be completed and operational so this would not materially change the assessment findings reported above.

7.7 Cumulative effects assessment

7.7.1 As detailed in para. 7.3.16 the Creekside Village East development on Copperas Street, 120m north of the site, is included in the cumulative effects assessment for the construction phase. Due to its distance from the site there would be no elevated effect as a result of this scheme.

7.7.2 No assessment of cumulative effects has been undertaken for the operational phase as no schemes have been identified in the development schedule (Vol 24 Appendix N) which would be under construction at this time.

Sensitivity test for programme delay

7.7.3 In the event that the programme for the Thames Tideway Tunnel project is delayed by approximately a year, a greater proportion of the Creekside Village development would be built and occupied with a corresponding reduced level of cumulative activity. Due to its distance from the site there would be no elevated effect on the construction phase as a result of this. No assessment has been undertaken of the cumulative effects of the historic character and setting of heritage assets in the operational phase because all the schemes set out in the development schedule would remain completed by the operational phase assessment year.

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 which 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 could be successfully mitigated by a suitable programme of archaeological investigation before and/or during construction, to achieve preservation by record (through advancing understanding of asset significance).

7.8.3 Mitigation requirements would be informed by selective site-based assessment. This could include a variety of techniques, such as geotechnical investigation, geoarchaeological deposit modelling, 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 7.8.7 below.

7.8.4 Subject to the findings of any subsequent field evaluation, mitigation of the adverse effects upon archaeological remains within the site is likely to include the following:

a. Mitigation of the impacts of deeper proposed construction works on palaeoenvironmental and prehistoric remains in the form of investigation and recording. This would only become feasible following the insertion of the perimeter walls or shaft segments of each construction (the shaft, the chambers etc) owing to the depth of alluvium on the site

b. An archaeological watching brief during demolition, ground clearance and construction to mitigate the impacts on the 19th century remains of low significance.

7.8.5 Mitigation of the impacts from demolition works and the construction of the CSO drop shaft, interception and valve chambers, and their associated connecting culvert and ventilation ducts on the late 19th to 20th century cooling tanks and pipework is described in para. 7.8.9 below, along with mitigation of effects on above-ground assets. This reflects their relationship with the standing structures on the site and the original Victorian sewer structures.

7.8.6 In the unlikely event of human remains being discovered on the site associated with a possible former 18th century chapel, archaeological excavation and recording would be required for any human remains present on the site. This would need to be undertaken under the terms of a Burial Licence from the Ministry of Justice. Remains associated with the Congregational Chapel would need to be reburied in consecrated ground after exhumation.

7.8.7 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.

Above-ground heritage assets

7.8.8 The moderate adverse effect from localised alterations to the Grade II listed Beam Engine House (an asset of high significance) and removal of the set of stairs to the East Beam Engine House on its northern side for the duration of the construction works, would be mitigated by a programme of standing structure survey and recording to English Heritage Level 3 standard (English Heritage, 2006)[4].

7.8.9 The moderate adverse effect on the cooling tanks and buried mid/late 19th and early 20th century sewage infrastructure, would be mitigated through recording prior to and during the works and incorporating the results into a programme of standing structure survey which would be carried out to English Heritage Level 2 standard. This survey would be undertaken following exposure of the cooling tanks, the redundant well, valve chamber, small auxiliary pumping chamber and the pipework connecting the cooling tanks to the East Beam Engine House, reflecting their relationship with the other above-ground heritage assets.

7.8.10 It is not intended to use intrusive or ground based mitigation, such as propping or grouting, to mitigate the effects of ground movement at the East and West Beam Engine Houses, as it is judged that the damaging effects of installing these measures would potentially be greater than the moderate adverse effects predicted from the ground movement generated by the proposed works. The listed building would be monitored during the works, and in the event of damage to its significance caused by ground movement, would be repaired on conclusion of the works, in accordance with the *CoCP* (Section 12), using standard conservation methods, to produce a like for like repair.

7.8.11 All measures embedded in the proposed development, *CoCP* and design principles of relevance to the assessment of effects on the historic character and setting of above-ground heritage assets are summarised in Section 7.2. No further mitigation during construction or operation is required as no significant adverse effects have been predicted.

7.9 Residual effects assessment

Construction effects

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

7.9.2 Following the repair of predicted damage as described in Section 7.8, the residual effects of settlement on Greenwich Pumping Station would be minor adverse.

7.9.3 As no mitigation measures are proposed for effects on the character and setting of above-ground heritage assets, the residual construction effects on the setting of heritage assets remain as described in Section 7.5. All residual effects are presented in Section 7.10.

Operational effects

7.9.4 As no mitigation measures are proposed for operational effects, which are all beneficial, 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 24 Table 7.10.1 Historic environment – summary of construction assessment

Receptor (Heritage asset)	Effect	Significance of effect	Mitigation	Significance of residual effect
Buried heritage assets				
High potential for palaeoenvironmental remains (Low to medium asset significance)	Assets removed by construction of CSO drop shaft. Asset significance reduced locally.	Minor adverse	Environmental sampling during archaeological investigation	Negligible
	Assets removed by construction of interception and valve chamber. Asset significance reduced locally.	Minor adverse	Environmental sampling during archaeological investigation	Negligible
Low potential for isolated prehistoric artefacts (Low asset significance)	Assets removed by construction of CSO drop shaft. Asset significance reduced locally.	Minor adverse	Archaeological investigation and recording to form preservation by record	Negligible
	Assets removed by construction of interception and valve chamber. Asset significance reduced locally.	Minor adverse	Archaeological investigation and recording to form preservation by record	Negligible
Low potential for isolated Roman artefacts (Low asset significance)	Assets removed by construction of interception and valve chambers. Asset significance reduced to negligible.	Minor adverse	Archaeological investigation and recording to form preservation by record	Negligible
Low potential for isolated early medieval artefacts (Low asset significance)	Assets removed by construction of interception and valve chambers. Asset significance reduced to negligible.	Minor adverse	Archaeological investigation and recording to form	Negligible

Receptor (Heritage asset)	Effect	Significance of effect	Mitigation	Significance of residual effect
			preservation by record	
Low potential for later medieval agriculture and reclamation (Low asset significance)	Assets removed by construction of CSO drop shaft, interception and valve chambers and connections Asset significance reduced locally.	Minor adverse	Archaeological investigation and recording to form preservation by record	Negligible
	Assets removed by site setup, demolitions and ventilation duct Asset significance reduced locally.	Minor adverse	Archaeological investigation and recording to form preservation by record	Negligible
Low potential for post-medieval agriculture and reclamation (Low asset significance)	Assets removed by construction of CSO drop shaft, interception and valve chambers and connections Asset significance reduced locally.	Minor adverse	Archaeological investigation and recording to form preservation by record	Negligible
	Assets removed by site setup, demolitions and ventilation duct Asset significance reduced locally.	Minor adverse	Archaeological investigation and recording to form preservation by record	Negligible
High potential for buried mid/late 19th and early 20th century pumping station infrastructure (Medium asset significance)	Assets removed by site setup and demolitions Asset significance reduced locally.	Moderate adverse	Archaeological investigation and recording to form preservation by record	Negligible
	Assets removed by construction of CSO drop shaft. Asset significance reduced locally.	Moderate adverse		Negligible
	Assets removed by construction of interception and valve chambers and	Moderate adverse		Negligible

Receptor (Heritage asset)	Effect	Significance of effect	Mitigation	Significance of residual effect
	ventilation structures Asset significance reduced locally.			
High potential for buried remains of post-medieval buildings pre-dating the pumping station (Low asset significance)	Assets removed by site setup, demolitions and ventilation duct Asset significance reduced locally.	Minor adverse	Archaeological watching brief to form preservation by record	Negligible
Low potential for burials associated with possible Congregational chapel (High asset significance, if present)	Assets removed by site setup, demolitions and ventilation duct Asset significance reduced locally.	Major adverse	Archaeological watching brief to form preservation by record. Reinterment under Ministry of Justice procedures.	Negligible
Above-ground heritage assets				
19th century East Beam Engine House (High asset significance)	Asset affected by localised modifications and refurbishment. Set of stairs to be removed temporarily and reconstructed. Asset significant reduced locally.	Moderate adverse	Level 3 standing structure survey to form preservation by record and inform sensitive reinstatement of stairs.	Negligible
	Ground movement generated by tunnelling, the construction of connection culvert and interception chamber, would result in a moderate damage risk to the building, with typical cracks of 5-15mm width.	Moderate adverse	Damage to significance would be made good with repairs using standard conservation methods, to achieve like for like repair. The building would be	Minor adverse

Receptor (Heritage asset)	Effect	Significance of effect	Mitigation	Significance of residual effect
			monitored.	
Greenwich Pumping Station and Coal Shed (High asset significance)	The use of the area as a work site would detract slightly from the historic character of the pumping station and its immediate setting	Minor adverse	No mitigation required further to that embodied within the proposed design and the *CoCP* and environmental design principles	Minor adverse
London and Greenwich Railway viaduct (High asset significance)	Given the industrial character of the asset and its setting, the presence of construction works would present a low magnitude of change	Minor adverse	No mitigation required further to that embodied within the proposed design and the *CoCP* and environmental design principles	Minor adverse
	Ground movement generated by tunnelling and construction works	Minor adverse	No mitigation required further to that embodied within the proposed design and the *CoCP* and environmental design principles	Minor adverse
Ashburnham Triangle Conservation Area (High asset significance)	The construction works would be largely screened by the presence of intervening buildings, although the crane towers would be visible from points within the Ashburnham Triangle Conservation Area	Minor adverse	No mitigation required further to that embodied within the proposed design and the *CoCP* and environmental design principles	Minor adverse
Deptford Creekside Conservation Area	The construction works would have a low magnitude of change to the setting	Minor adverse	No mitigation required further to that embodied	Minor adverse

Receptor (Heritage asset)	Effect	Significance of effect	Mitigation	Significance of residual effect
	of the industrial part of the conservation area nearest to the site		within the proposed design and the *CoCP* and environmental design principles	

Vol 24 Table 7.10.2 Historic environment – summary of operational assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
East Beam Engine House (High asset significance)	Asset affected by sensitive modification, bringing building back into use.	Moderate beneficial	None	Moderate beneficial
Greenwich Pumping Station (High asset significance)	The proposed wildflower meadow would enhance the setting of the Greenwich Pumping Station.	Minor beneficial	None	Minor beneficial
London & Greenwich Railway viaduct (High asset significance)	The proposed landscape design would enhance the setting of the asset	Minor beneficial	None	Minor beneficial
Ashburnham Triangle Conservation Area (High asset significance)	The small scale operational development would be screened from the setting of Ashburnham Triangle Conservation Area by the presence of intervening development	Minor beneficial	None	Minor beneficial
Deptford Creekside Conservation Area	There would be improvements to the setting of the Pumping Station, with a negligible magnitude of change to the setting of the conservation area.	Minor beneficial	None	Minor beneficial

References

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

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

[3] 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)

[4] English Heritage. *Understanding historic buildings: a guide to good recording practice.* Swindon (2006).

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

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Volume 24: Greenwich Pumping Station site assessment

Section 8: Land quality

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Environmental Statement

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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 Greenwich Pumping Station 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[1] 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 and how this would impact upon the ecology and quality of water in the tidal reaches of the River Thames. 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 is made in the land quality section.

[1] 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 Section 8, Vol 2 Table 8.3.1). *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 24 Greenwich Pumping Station 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. demolition of existing industrial buildings

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

c. combined sewer overflow (CSO) drop shaft, the invert of which would be located at a depth of approximately 46m below ground level (bgl), located within the Chalk

d. connection tunnel to the main tunnel (Greenwich connection tunnel), via Chambers Wharf

e. construction of an interception chamber, CSO overflow structures, chambers, culverts and other hydraulic structures

f. installation of electrical control equipment

g. construction of air management plant and equipment including filters and ventilation columns, ducts and chambers.

8.2.3 The above works would involve extensive below ground construction, resulting in the excavation and removal of material, including Made Ground and natural soils below.

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 Greenwich Pumping Station 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, Royal Borough (RB) of Greenwich, 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 24 Appendix F.1) and 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 Greenwich Pumping Station site to inform ground investigation work (see Vol 24 Appendix F.2).

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

8.2.9 In addition to the above, land quality will continue to be assessed via the following measures:

a. preparation of a preliminary risk assessment, and if necessary the completion of additional ground investigation surveys which could include the collection of soil and water samples for laboratory chemical testing and environmental monitoring (such as soil gas and soil vapour). A phased approach would be applied to ground investigation, with additional, detailed phases of investigation implemented as necessary to supplement, target and refine the findings and conclusions of the earlier assessments

b. site-specific land quality risk assessments would identify the need for specific remediation measures. Where necessary, the risk assessment would also be used to provide re-use criteria for soil material to be permanently placed at the site.

8.2.10 Where the site-specific land quality risk assessment identifies the need, a site-specific remediation strategy would be produced and implemented, including:

a. remedial options appraisal (as required)

b. details of the remediation strategy and methodology

c. methodology for decommissioning and removal of structures, such as underground storage tanks, if and where encountered

d. details of validation requirements to document the successful clean-up works.

Construction

8.2.11 Health and safety measures for the protection of construction workers with respect to land quality issues would include:

a. the provision of adequate training for all construction site workers to recognise and appropriately respond to potential land quality issues

b. site welfare facilities and where appropriate, decontamination units (ie, dirty in, clean out welfare units)

c. use of standard construction site personal protective equipment (PPE) (eg, high visibility clothing, safety boots, hard hat, safety glasses gloves and respiratory equipment)

d. robust emergency procedures (eg, with respect to UXO, previously unidentified contamination or structures), which are periodically reviewed. In the event of previously unidentified conditions being encountered, works would be suspended, the work area evacuated and specialist advice obtained. Where appropriate, 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. Excavated materials with the potential to be contaminated would be removed from site as soon as practicable. Site control measures would be implemented to reduce dust (see air quality section of the *CoCP*) and the spread of mud by vehicles (see public access, the highway and river transport section of the *CoCP*).

8.2.13 Environmental monitoring, would include the following measures:

a. on-site watching brief during potentially high risk activities and an on call watching brief for all other activities. Specialist watching brief may include: UXO; contaminated land; health and safety/occupational health; and ecological (for invasive species, such as Japanese Knotweed)

b. dust and air/vapour monitoring (see *CoCP* Section 9 for further details). Where appropriate, this would include a combination of on-site and boundary monitoring.

8.3 Assessment methodology

Engagement

8.3.1 Volume 2 Environmental assessment methodology documents the overall engagement which has been undertaken in preparing the *Environmental*

Statement. Specific comments relevant to this site for the assessment of land quality are presented here.

8.3.2 The RB of Greenwich was specifically consulted with respect to any land quality data they hold at the site and surrounding area. The authority provided two site investigation reports for nearby sites, a review of this data is presented in Vol 24 Appendix F.1.

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. 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.

8.3.5 The construction assessment has been undertaken for Site Year 1 of the construction phase.

8.3.6 The base case and cumulative assessment in Site Year 1 of construction take into account the schemes described in Vol 24 Appendix N. The baseline is expected to change between the base case year and Site Year 1 of construction (2016). There are four developments within the 250m buffer area (as shown in Vol 24 Table 8.3.1) which are likely to be complete and operational before the commencement of the construction phase and as a result form part of the construction base case.

8.3.7 The developments within the 250m buffer area which are not considered as part of the construction base case are those developed during and after Site Year 1 of construction and are also identified in Vol 24 Table 8.3.1 .

Vol 24 Table 8.3.1 Land quality – construction base case and cumulative assessment development (2016)

Development	Distance from site	Construction base case	Cumulative impact assessment
83-87 Greenwich High Road (demolition of existing buildings, construction of a mixed use development comprising retail/commercial and residential properties)	Adjacent	✓	✗
Greenwich Industrial Estate, land bounded by Norman Road, Greenwich	Adjacent	✓	✗

Development	Distance from site	Construction base case	Cumulative impact assessment
High Road and Waller Way (redevelopment of site for mixed use developments comprising residential units and community uses)			
Hiltons Wharf, 30-52 Norman Road, Greenwich (demolition of existing building and construction of residential units and commercial floorspace)	35m north	✓	✗
Site of old Seager Distillery and Norfolk House, 4-12 Deptford Bridge (redevelopment of Seager Building Site/Deptford Bridge/Brookmill Road and Norfolk House sites to provide residential and commercial properties and leisure and retail facilities),	250m southwest	✓	✗
Creekside Village East (Thanet Wharf) Copperas Street (demolition of existing buildings/structures and the construction of mixed use development including leisure, commercial, residential, health and landscaping)	120m north	✗	✓

Symbols ✓ applies ✗ does not apply

8.3.8 Section 8.5 details the likely significant effects arising from the construction at the Greenwich Pumping Station 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

8.3.9 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.

8.3.10 The SPR conceptual model is based on guidance given in CLR11: *Model procedures for the management of land contamination* (EA, 2004)[2]. 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.

8.3.11 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.

8.3.12 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.

8.3.13 The methodology for undertaking both source-pathway-receptor analysis and the impact assessment is provided in Vol 2 Section 8.

Assumptions and limitations

8.3.14 The assumptions and limitations associated with this assessment are presented in Vol 2. Assumptions and limitations specific to the site are detailed below.

Assumptions

8.3.15 The approach to remediation cannot be defined at this stage due to a lack of data. It is therefore assumed that some contamination would still remain on-site at the time construction commences (either because no pre-commencement remediation is deemed necessary or that following remediation of the construction area some contamination remains on the wider site).

Limitations

8.3.16 There are no site-specific limitations in relation to land quality at Greenwich Pumping Station.

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 24 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 24 Appendix F, this section should be read in conjunction with Vol 24 Figure F.1.1, Vol 24 Figure F.1.2 and Vol 24 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 Made Ground extending to 2.1m bgl. This is underlain (in turn) by Alluvium, River Terrace Deposits, Lambeth Group, Thanet Sand formation and Chalk Group (see Vol 24 Appendix F.1, Vol 24 Table F.3 for the full geological succession).

Contamination

8.4.5 The southern part of the site (shaft location and associated construction compound) has formed part of the Greenwich Pumping Station since the mid 19th Century with associated coal fired boilers, fuel tanks, engines, electrical switchgear. The northern part of the site contained buildings associated with the railway from the late 19th century, which subsequently formed the Phoenix Wharf during the early 20th century and used as a builders merchants from the 1980s.

8.4.6 The area surrounding the site has previously supported a variety of potentially contaminative land-uses including a former gas works located approximately 60m west of the site, chemical works (later engineering works) 50m west and numerous wharf areas located along Deptford Creek.

8.4.7 The main contaminants associated with the on-site and off-site land uses may include hydrocarbons, benzene, toluene, ethylbenzene and xylene, cyanides, phenols, PAHs, polychlorinated bi-phenyls (PCBs), metals and VOCs.

8.4.8 Ground investigations on the adjacent land to the south (a former engineering works) recorded locally elevated metals and PAHs in soils with some relatively minor TPH in groundwater.

8.4.9 Within the Greenwich Pumping Station site two phases of intrusive ground investigations have been undertaken in order to provide site specific data on soil and groundwater conditions. No evidence to suggest the presence of widespread contamination was recorded on borehole logs. Laboratory testing of soils for a wide range of contamination has also recorded no elevated soil contamination in comparison with human health risk assessment screening values for commercial/industrial land-use (Defra, 2009)[3], (Land Quality Management/Chartered Institute of Environmental Health, 2009)[4] (where available).

8.4.10 Exposed sediments in the foreshore were also tested as part of the baseline data gathering. The testing recorded sediments are generally not elevated in terms of risk to human health but slightly elevated over PLA approved sediment quality guidelines (for the protection of aquatic organisms (Canadian Council for the Environment, 2001[5]) (see the sediment report Vol 2 Appendix F.2).

8.4.11 Impacts to groundwater by TPH, PAHs and metals have however been identified (see Section 13 for further information on groundwater quality and assessment of impacts).

8.4.12 Japanese Knotweed, an invasive species has also been recorded within the site.

UXO

8.4.13 A desk based assessment for UXO threat was previously undertaken by specialists for previous ground investigation works on part of the proposed development site. The report reviews information sources such as the Ministry of Defence, Public Records Office and the Port of London Authority (PLA). The report is presented in Vol 24 Appendix F.2.

8.4.14 The report found that pumping station and surrounding wharves were bombing targets and two bomb strikes were recorded in the search buffer. Extensive bomb damage was recorded.

8.4.15 Taking into account redevelopment of much of the area since World War II, it was considered that there is an overall low to medium threat from UXO at the Greenwich Pumping Station site.

Summary of receptors

8.4.16 The receptors identified at this site from the baseline survey (see Vol 24 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: residents (high sensitivity), workers in the adjacent industrial or commercial land and public right of way users (low sensitivity)

c. built environment: existing pumping station and associated infrastructure, commercial, industrial and residential properties located off-site (low sensitivity) and listed structures, such as the railway viaduct and buildings associated with the original Deptford Pumping Station within the south of the site (high sensitivity).

Construction base case

8.4.17 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 The embedded requirement for a risk assessment and potential remediation of land contamination that forms part of the proposed development (refer to the *CoCP* Section 9 and summary presented in Section 8.2) means that the land quality of the site may be different to that described in Section 8.4.

8.5.2 Where deemed necessary, problematic or gross contamination, which may substantially hinder the construction programme or which cannot be adequately dealt with in a controlled manner during construction, would have been remediated prior to the commencement of the main construction works (such as the main tunnel shaft, main tunnel construction works and in other areas of proposed excavation, where necessary).

8.5.3 Since the approach to remediation cannot be defined at this stage, it is assumed that some contamination would remain. Therefore some contamination is considered to be present for the purposes of this assessment.

8.5.4 Unless there are any immediate (as yet unknown) unacceptable risks elsewhere (for instance off-site migration of mobile free phase hydrocarbons or vapour risk to adjacent properties), remediation in areas away from planned intrusive construction works would not take place prior to construction.

Development of conceptual model

Interactions between source-pathway-receptor

8.5.5 The following section outlines how the contamination sources summarised in paras. 8.4.4 to 8.4.10 may interact with the receptors identified during the construction phase (see para. 8.4.16) following the application of the embedded measures (see Section 8.2).

8.5.6 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 or through the spread of Japanese Knotweed rhizome impacted soils excavated as part of construction works.

8.5.7 The SPR interactions are summarised in Vol 24 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 24 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 and vapour migration (and subsequent ingestion and inhalation)	N/A
Contaminated groundwater or liquids	Inhalation, dermal contact, ingestion	Migration in upper and lower aquifer	N/A
Soil gases/vapours	Inhalation	Vapour migration (and subsequent inhalation)	N/A

Receptors / Generic sources	Construction workers	Adjacent land-users	Built environment
UXO	UXO detonation	UXO detonation	UXO detonation
Japanese Knotweed	N/A	N/A	Spread of rhizomes

N/A= Not applicable

Impacts and effects

8.5.8 The following section discusses the potential impacts and likely significant effects on receptors as a result of the land quality conditions at the site.

8.5.9 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

8.5.10 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

8.5.11 The management of contamination at the site is a two stage process, the first stage comprises the assessment, quantification and if necessary the removal of the main contamination sources which could impact upon construction worker health.

8.5.12 The second stage comprises safe methods of work and management of contamination during construction (assuming either that some contaminated soils could remain, or previously unidentified contamination be found during the main construction works).

8.5.13 Both of these stages include measures such as site-specific risk assessments, watching brief, safe methods of work, use of PPE and mitigation from a specialist contractor who is experienced at managing such risks.

8.5.14 With these measures in place, the overall magnitude of the impact to construction workers (both below and above ground) is assessed to be negligible.

8.5.15 This would result in a **negligible** effect on above ground construction workers and a **minor adverse** effect on those involved in intensive below ground works (although the effect is defined as minor adverse, it is considered unlikely that the effects would occur).

UXO

8.5.16 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 Greenwich Pumping Station 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.

8.5.17 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.

8.5.18 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

8.5.19 Impacts on adjacent land-users could occur via excavation and exposure of previously unidentified contaminated soils. This contamination could then migrate onto neighbouring sites. The pathways via which the contamination could migrate are: wind-blown dust and vapour diffusion.

8.5.20 A number of embedded measures set out in the *CoCP* Section 9, as summarised in Section 8.2, are designed to effectively manage any land quality impacts to the adjacent land-users associated with the construction phase of the proposed development.

8.5.21 These measures include:

a. the damping down of excavations, storage of potentially contaminated soils in secure (covered) areas, wheel washes at site entrance and the maintenance, construction and cleaning of hardstanding

b. dust and air/vapour monitoring to provide a check that volatile contamination or construction dusts do not significantly affect adjacent land users. Where appropriate, this would include a combination of on-site and boundary monitoring, which would provide either real time measurements or collect samples for subsequent analysis. For further detail and guidance reference should be made to the *CoCP* Section 9.

8.5.22 With these measures in place the overall magnitude of the impact to all adjacent land-users is assessed to be negligible.

8.5.23 Based on the assessed impact magnitude and receptor sensitivity, it is considered that the proposed development would result in a **negligible** effect on the adjacent industrial/commercial land and public right of way users and a **minor adverse** effect on the adjacent residential land-users (although the effect is defined as minor adverse, it is considered unlikely that the effect would occur).

UXO

8.5.24 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.

8.5.25 With these measures in place the overall magnitude of the impact to all adjacent land-users is assessed to be negligible.

8.5.26 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 industrial/commercial land and public right of way users and a **minor adverse** effect on the adjacent residential land-users (although the effect is defined as minor adverse, it is considered unlikely that the effect would occur).

Built environment

8.5.27 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 from UXO and Japanese Knotweed to the built environment associated with the construction phase of the proposed development.

UXO

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

8.5.29 With the embedded design measures in place the overall magnitude of the impact to the built environment is assessed to be negligible.

8.5.30 Based on the assessed impact magnitude and receptor sensitivity it is considered that the proposed development would result in a **negligible** effect on the existing infrastructure at Greenwich Pumping Station, residential, industrial and commercial properties and a **minor adverse** effect on the listed structures at the site, such as the railway viaduct and buildings associated with the original Deptford Pumping Station (although the effect is defined as minor adverse, it is considered unlikely that the effects would occur).

Japanese Knotweed

8.5.31 Impacts from existing land quality relate to the spread of Japanese Knotweed which, if left uncontrolled, can cause damage to structures and services.

8.5.32 With the embedded design measures in place the overall magnitude of the impact to the built environment is assessed to be negligible.

8.5.33 Based on the assessed impact magnitude and receptor sensitivity it is considered that the proposed development would result in a **negligible** effect on the existing infrastructure at Greenwich Pumping Station, residential, industrial and commercial properties and a **minor adverse** effect on the listed structures at the site such as the railway viaduct and buildings associated with the original Deptford Pumping Station (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

Construction effects

8.7.1 Of the projects described in Vol 24 Appendix N, which could potentially give rise to cumulative effects with the proposed development at Greenwich Pumping Station, two developments have been identified (see Vol 24 Table 8.3.1).

8.7.2 No cumulative effects of land quality are expected during the construction of the Thames Tideway Tunnel project, since impacts would be constrained to the footprint of the development by the measures incorporated in the *CoCP* Section 9.

8.8 Mitigation

8.8.1 The assessment presented above does not identify the need for mitigation during construction, over and above those measures set out in the *CoCP* . No further mitigation, enhancement or monitoring is required.

8.9 Residual effects assessment

Construction effects

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 24 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, sediment, liquids, 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, sediment, liquids, soil gases/ vapours	Minor adverse	None	Minor adverse*
	Health effects from detonation of UXO	Minor adverse	None	Minor adverse*
Adjacent land-users, industrial/commercial and public right of way land-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, 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 –existing structures associated with Greenwich Pumping Station and industrial/commercial buildings (Low)	Damage to structures from detonation of UXO	Negligible	None	Negligible
	Damage to structures from spread of Japanese Knotweed	Negligible	None	Negligible

Receptor (sensitivity)	Effect	Significance of effect	Mitigation	Significance of residual effect
Built environment – listed railway viaduct and listed buildings associated with the original Deptford Pumping Station (High)	Damage to structures from detonation of UXO	Minor adverse	None	Minor adverse*
	Damage to structures from spread of Japanese Knotweed	Minor adverse	None	Minor adverse*

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

References

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

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

[3] Defra. *Soil Guidance Values* (2009).

[4] Land Quality Management/Chartered Institute of Environmental Health. *Generic Assessment Criteria for Human Health Risk Assessment*, 2nd Edition, Land Quality Press (2009).

[5] Canadian Council for the Environment. *Sediment Quality Guidelines for the Protection of Aquatic Life*. Available at: http://st-ts.ccme.ca/. Accessed 4th January 2012.

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.24**

Volume 24: Greenwich Pumping Station site assessment

Section 9: Noise and vibration

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

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Thames Tideway Tunnel

Environmental Statement

Volume 24: Greenwich Pumping Station 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 Greenwich Pumping Station site.

9.1.2 The proposed development has the potential to affect noise and vibration levels at receptors due to:

a. construction site activities (noise and vibration)

b. construction traffic on roads outside the site (noise)

c. operation of the proposed development (noise and vibration).

9.1.3 Each of these is considered within the assessment.

9.1.4 The Greenwich Pumping Station site is a CSO interception site and the drive site for the long connection tunnel drive to Chambers Wharf. The main tunnel drive does not run beneath this location. Groundborne noise and vibration from the tunnelling activities associated with the main tunnel, long connection tunnels and certain short connection tunnels are considered in Volume 3 Project-wide and cumulative assessment.

9.1.5 It is not proposed to use the river to transport materials at this site; therefore, effects as a result of river-based construction traffic are not considered at this site.

9.1.6 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.

9.1.7 Plans of the proposed development as well as figures included in the assessment for this site are contained in a separate volume (Volume 24 Greenwich Pumping Station 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 The delivery and removal of all materials would be by road. Estimated vehicle numbers and haul routes are presented in Section 12.2.

Construction activities

9.2.3 Vol 24 Section 3.3 sets out the assumed construction duration and programme for the Greenwich Pumping Station 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
d. diaphragm wall construction
e. shaft construction
f. tunnelling
g. tunnel secondary lining
h. shaft secondary lining
i. near ground structures and culvert works
j. renovation of the East Beam Engine House and installation of ventilation equipment within it
k. landscaping (including construction and fit-out of permanent facilities).

9.2.5 Further detail on the plant used in these construction stages is given in Vol 24 Appendix G.

9.2.6 Working hours have been be 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:

a. standard hours (08.00-18.00 weekdays and 08.00-13.00 Saturdays).
b. extended working hours (18.00-22.00 weekdays, 13.00-17.00 Saturdays) to complete large concrete pours. These are assumed approximately twice a week for approximately four months during the diaphragm walling works and then once a month for other major concrete pours.
c. continuous working (24 hours a day, 7 days a week) during the long connection tunnel drive for a period of approximately 20 months and connection tunnel secondary lining for a period of approximately eight months.

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 have been incorporated into the *CoCP Part B* (sections 4 and 6) to reduce noise and vibration at Greenwich Pumping Station. These comprise:

a. the construction area around the main shaft will be covered by an enclosure/building during the main tunnel construction and secondary lining works. The building would have cladding with a specified sound reduction value. Building openings would be designed to be away from sensitive noise receptors and would be kept closed when not in use at night. There would only be essential use of openings at night.

b. provision of a three-sided noise screen with roof around the materials handling area

c. the site hoarding would be 3.6m high at this site

Operation

9.2.10 Ventilation plant would be housed within the existing East Beam Engine House. In addition, pressure relief plant would be housed within the top of the drop shaft. The operational 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 shaft below. The potential for noise generated by this movement of water through the shaft has been assessed.

Environmental design measures

9.2.12 The Greenwich Pumping Station site shaft is both a CSO drop shaft and a shaft site for the Greenwich connection tunnel. The operational plant associated with the surface structures would incorporate environmental design measures to control noise emission to acceptable noise limits as defined by the Royal Borough (RB) of Greenwich (see para. 9.3.16). The environmental design measures have considered the following noise sources:

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

b. ventilation plant within the East Beam Engine House.

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.

Assessment methodology

9.3 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 were agreed with RB of Greenwich and LB of Lewisham. The limits for plant noise from the operation of the site were also agreed with RB of Greenwich (see para. 9.3.16).

9.3.3 Written confirmation on the survey methodology was received from RB Greenwich in June 2011.

9.3.4 Consultation comments relevant to this site for the assessment of noise and vibration are presented in Vol 24 Table 9.3.1. There were no other site specific comments from stakeholders in relation to noise and vibration raised at scoping or other consultation stages.

Vol 24 Table 9.3.1 Noise and vibration – consultation comments

Organisation	Comment	Response
Royal Borough of Greenwich, phase two consultation response, February 2012	It is probable that the proposed development at the Greenwich industrial estate will be occupied by the time these works commence. The acoustic properties of the proposed temporary structure around the main workings have not been described. As the main tunnelling works are to operate on a 24 hour basis, this structure will provide the main protection against noise from the activities affecting sensitive receptors and consideration should be given	The EIA assessment considers the connection tunnel works over a 24 hour period, and the noise levels reported assume that the enclosure over the shaft would be in place during this period. The minimum specifications for the enclosure are contained within the *CoCP*. It is essential that the

Organisation	Comment	Response
	to the nature of this structure as soon as possible. Therefore, if the drop shaft construction takes place prior to the construction of the temporary enclosure, the extended standard working hours should be resisted for this phase of works.	diaphragm wall panels are constructed in continuous operation and so would still require extended hours for this phase. Noise attenuation would be put in place as per the *CoCP*.

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 Greenwich Pumping Station. 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 (Years 1 to 6) and the worst-case exposure levels are reported. The development case (with the Thames Tideway Tunnel project) has been assessed against the base case (without the Thames Tideway Tunnel project).

9.3.9 Of the schemes identified in the development schedule (Vol 24 Appendix N), the following are considered relevant for the construction assessment base case as they are assumed to be complete and operational before or during the Thames Tideway Tunnel construction period:

a. Block E of the 43-81 Greenwich High Street development. The building is currently complete however the usage would be hotel rooms rather than office space.

b. The 83-87 Greenwich High Road mixed use development,

c. Greenwich Industrial Estate (The Movement) mixed use development,

d. Hilton's Wharf. This development is equidistant from the site to residential development on Tarves Way (The Rubicon), and has therefore been included by reference to the Rubicon residential receptor

9.3.10 The Creekside Village East development is considered relevant to the construction cumulative assessment as it would be under construction at the same time as the Thames Tideway Tunnel in Site Year 1 of construction.

9.3.11 All other schemes in the development schedule (Vol 24 Appendix N) are either further away from the site than other receptors which have been considered or outside of the assessment screening distance of 300m and are therefore not considered in this assessment.

9.3.12 Traffic flows on construction traffic routes have been examined to determine if there are any routes where there is the potential for traffic noise changes of 1dB(A) or more. This is according to the flow, speed or composition change criteria specified in Volume 2. The results show that there are no traffic changes on the road network associated with this site which meet the relevant criteria. This is discussed further in the assessment section from para. 9.5.50.

9.3.13 The assessment of construction effects also considers the extent to which the effects on noise and vibration would be likely to be materially different should the programme for the Thames Tideway Tunnel project be delayed by approximately one year.

Construction assessment area

9.3.14 As described in Volume 2 the assessment area considers unscreened receptors up to a maximum of 300m from the site boundary based on professional judgement of the likelihood of significant effects. The assessment primarily concentrates on those receptors closest to the site which would generally be most affected, rather than those further away which would be well screened by intervening buildings. Effects at more distant receptors beyond those closest to the site have been considered where necessary by reference to the impacts determined at the primary (closest) receptors.

Operation

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

9.3.16 For residential receptors, the requirements of RB of Greenwich have been taken into account as all residential receptors at this site fall within the RB of Greenwich. RB of Greenwich has requested in the noise from operational plant criterion that there is no increase in background noise levels. This has been interpreted that noise levels would be 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.

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

9.3.18 Section 9.6 details the likely significant effects arising from the operation of the Greenwich Pumping Station site. There are no other Thames Tideway Tunnel project 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.

9.3.19 Of the schemes identified in the development schedule (Vol 24 Appendix N), the 83-87 Greenwich High Road and Greenwich Industrial Estate (The Movement) developments are considered relevant to the operational assessment base case as they have been assumed to be complete by Year 1 of operation. Those not considered relevant are either represented by receptors nearer the development, or are located outside of the 300m assessment area.

9.3.20 There are no schemes identified in Vol 24 Appendix N that are considered relevant for the operational cumulative assessment, because due to their use none are expected to generate significant noise or vibration levels during their operation.

9.3.21 Based on the traffic flow, speed or composition change criteria specified in Volume 2, there are no routes where the potential for operational traffic noise effects would occur.

9.3.22 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

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

Assumptions and limitations

9.3.24 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.

Assumptions

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

9.3.26 The operational noise assessment is based on $10m^3/s$ centrifugal ventilation fans being housed within a purpose built air management plant building and includes all aspects of noise generation such as plant noise and wind noise through ducts and vent columns. The noise emission predictions have been based on data for typical plant at the appropriate operating settings. FläktWood’s HCGB 080 centrifugal fans at a pressure drop of 1170Pa and a speed of 1500rpm have been typically applied.

Limitations

9.3.27 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 full 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 24 Appendix G. Vol 24 Table 9.4.1 below shows that the noise levels for the daytime period are influenced by their proximity to the major noise sources around the site; noise from train services on the DLR and national rail services to the north; steady road traffic on Greenwich High Road and occasional traffic on Norman Way and other smaller connecting roads in the vicinity.

9.4.3 It is understood that prior to Site year 1, the existing diesel storm pumps would be replaced by electric pumps powered by a diesel generator. Although these are likely to be quieter than the existing pumps, the baseline noise conditions are unlikely to be affected as the main contributor to the noise climate is road and rail traffic.

Receptors

9.4.4 This section describes the setting and receptor characteristics of the site for the purposes of this assessment.

9.4.5 The closest noise and vibration sensitive receptors selected for the noise and vibration assessment are identified in Vol 24 Table 9.4.1 below (and shown in plan view in Vol 24 Figure 9.4.1 – see separate volume of figures). These were selected as they are representative of the range of noise climates where sensitive receptors are situated around the site. The approximate number of residential properties affected at each location (where known) is indicated in Vol 24 Table 9.4.2.

9.4.6 The nearest residences to the development are those within the 43-81 Greenwich High Road development to the southwest of the site. There are also residences within The Movement development, located on Norman Road to the east of the site, at the Rubicon development on Tarves Way to the north of the site and at 83-87 Greenwich High Road to the southeast of the site. The hotel rooms in Block E of the 43- 81 Greenwich High Road development has been considered as has Norman House, an office building on the corner of Norman Road. On the opposite side of the creek are offices and warehouses. These are all within the RB of Greenwich.

9.4.7 Beyond these closest receptors there are other non-residential locations, generally office buildings, which are screened from the site by intervening buildings. These include residences on Egerton Drive, Tarves Way and Greenwich High Road and non-residential properties such as the Faircharm Trading Estate, Brookmarsh Industrial Estate, Lewisham College and Millers Public House. These properties have been considered as secondary receptors.

Receptor sensitivity

9.4.8 The sensitivities of noise and vibration receptors have been determined using the methodology outlined in Volume 2 Section 9.4. The sensitivities of all assessed receptors are presented in Vol 24 Table 9.4.1 along with the measured average ambient noise levels at each corresponding survey location.

Vol 24 Table 9.4.1 Noise and vibration – sensitive receptors and noise levels

Ref	Receptor addresses	Sensitivity	Local authority	Measured average ambient noise level, day/ evening/ night, dBL_{Aeq*}	Noise survey location
GP1	Hatfield House - 43-81 Greenwich High Road (residential)	High	RB of Greenwich	67/64/54	GPS03
GP2	Torrent Lodge - 43-81 Greenwich High Road (residential)	High	RB of Greenwich	67/64/54	GPS03
GP3	Block E - 43-81 Greenwich High Road (hotel at upper floors)	Medium	RB of Greenwich	61/58/54	GPS01
GP4	83-87 Greenwich High Rd (residential)	High	RB of Greenwich	61/58/54	GPS01
GP5	Norman House (offices)	Medium	RB of Greenwich	63/60/52	GPS02
GP6	The Movement (residential)	High	RB of Greenwich	63/60/52	GPS02
GP7	Rubicon (residential)	High	RB of Greenwich	63/60/52	GPS02
GP8	Paxton Point - 43-81 Greenwich High Road (residential)	High	RB of Greenwich	67/64/54	GPS03

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

9.4.9 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).

9.4.10 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 Greenwich Pumping Station site are as shown in Vol 24 Table 9.4.2. As described in the assessment methodology, this follows the method as defined in Vol 2 Table 9.5.1.

9.4.11 The assessment of significance at non-residential receptors is made according to the construction noise level relative to the ambient noise level (see Vol 24 Table 9.4.2) using the impact criteria described in Vol 2 Section 9.5 (where appropriate) and other factors described in Volume 2.

Vol 24 Table 9.4.2 Noise – residential receptors and assessment categories

Ref	Noise sensitive receptor* (No. of dwellings)	Ambient noise level, rounded to nearest 5dBL_{Aeq}* day/ evening/ night	Assessment category* day/ evening/ night	Significance criterion threshold level*, day, dB$L_{Aeq\ 10hour}$/ evening dB$L_{Aeq\ 1hour}$/ night, dB$L_{Aeq\ 1hour}$
GP1	Hatfield House - 43-81 Greenwich High Road (15)	65/65/55	B/C/C	70/65/55
GP2	Torrent Lodge - 43-81 Greenwich High Road (70)	65/65/55	B/C/C	70/65/55
GP4	83-87 Greenwich High Rd (3)	60/60/55	A/C/C	65/65/55
GP6	The Movement (-)	65/60/50	B/C/C	70/65/55
GP7	Rubicon (31)	65/60/50	B/C/C	70/65/55

Ref	Noise sensitive receptor* (No. of dwellings)	Ambient noise level, rounded to nearest 5dBL_{Aeq}* day/ evening/ night	Assessment category* day/ evening/ night	Significance criterion threshold level*, day, dB$L_{Aeq\ 10hour}$/ evening dB$L_{Aeq\ 1hour}$/ night, dB$L_{Aeq\ 1hour}$
GP8	Paxton Point - 43-81 Greenwich High Road (62)	65/65/55	B/C/C	70/65/55

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

Construction base case

9.4.12 The construction base case taking into account the schemes described in Section 9.3 includes the hotel in Block E of 43-81 Greenwich High Road, 83-87 Greenwich High Road and The Movement, all of which fall within the assessment area and are assumed to be compete and operational before or during the Thames Tideway Tunnel construction period.

9.4.13 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 considered likely they would increase compared to the measured data from 2011 due to natural traffic growth and the potential for additional construction noise from adjacent developments. The estimated traffic increases for the construction base case in Site Year 1 are such that noise levels would be expected to increase by less than 1dB(A) from those measured in 2011. The assessment based on data from 2011 therefore presents a worst case assessment.

9.4.14 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.

9.4.15 Adjacent to the site there are viaducts for the DLR and national rail line, which are relatively low vibration sources. There are no other major vibration sources immediately alongside the site. In the absence of any increase in the size or frequency of trains on the DLR or the adjacent national rail line, it is considered that vibration levels are unlikely to change between the present time and the base case.

Operational base case

9.4.16 The base case in Year 1 of operation taking into account the schemes described in Section 9.3 would not differ from that set out in the construction base case as 43-81 Greenwich High Road, 83-87 Greenwich High Road and The Movement would be complete and operational.

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 one 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 24 Table 9.5.1 and Vol 24 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 24 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 24 Appendix G Plates G.4 to G.11 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. The predicted impacts and assessed effects at each representative receptor location are described below.

Impacts at residential receptors

9.5.3 The results for residential receptors are shown below.

Vol 24 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 <u>all</u> 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
GP1 Hatfield House - 43-81 Greenwich High Road (15)	70	45 – 71 (day)	65	1	+1*	1
	65	46 – 47 (eve)	47	0	-18	0
	55	41 – 42 (night)	42	0	-13	0
GP2 Torrent Lodge - 43-81 Greenwich High Road (70)	70	46 – 72 (day)	65	1	+2*	1
	65	46 – 47 (eve)	47	0	-18	0
	55	37 – 40 (night)	40	0	-15	0
GP4 83-87 Greenwich High Rd (11)	65	49 – 67 (day)	61	1	+2*	1
	65	49 – 50 (eve)	50	0	-15	0
	55	38 – 41 (night)	41	0	-14	0
GP6 The Movement (-)	70	46 – 74 (day)	70	7	+4*	3
	65	52 – 55 (eve)	55	0	-10	0
	55	52 – 55 (night)	55	0	0	0
GP7 Rubicon (31)	70	43 – 62 (day)	62	0	-8	0
	65	47 – 52 (eve)	52	0	-13	0
	55	45 – 49 (night)	49	0	-6	0
GP8 Paxton Point - 43-81 Greenwich High Road (62)	70	24 – 64 (day)	54	0	-6	0
	65	37 – 42 (eve)	42	0	-23	0
	55	37 – 41 (night)	41	0	-14	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

Hatfield House (GP1)

9.5.4 Hatfield House is a six storey building located approximately 5m from the southern site boundary and approximately 120m from the proposed shaft. The second floor and above would overlook the site offices, workers entrance and car park, but would be partly screened from the shaft site and wholly screened from the materials handling area to the north of the railway viaduct. Due to the height of the building, it would not be screened by the site hoardings. The predicted noise levels at these dwellings due to construction activities are shown in Vol 24 Table 9.5.1.

9.5.5 The typical daytime noise levels (most frequently occurring monthly level) is 65dBL_{Aeq}. The site establishment works are expected to cause the worst-case noise levels of 71 dBL_{Aeq} for one month.

9.5.6 During the evening and night-time, the construction of the connection tunnel is expected to cause the worst-case noise levels of 47dBL_{Aeq} and 42dBL_{Aeq} respectively.

9.5.7 The construction noise levels are not estimated to exceed the potential significance criteria during the evening and night-time. But the construction noise levels are estimated to exceed the potential significance criteria during the daytime for one month. During the remainder of the construction period the noise levels would be below the potential significance criteria.

9.5.8 Given the small magnitude that the potential significance criteria are exceeded by and the short duration, the effect is therefore assessed as **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.

Torrent Lodge (GP2)

9.5.10 Torrent Lodge is a six storey building. The second floor and above would not be screened from the site offices and workers entrance and car park, but would be entirely screened from the shaft site by the pumping station building and from the materials handling area by the railway viaduct. It lies at a distance of some 5m from the southern site boundary, and 140m from the shaft itself. The predicted noise levels at these dwellings due to construction activities are shown in Vol 24 Table 9.5.1.

9.5.11 The typical daytime noise levels (most frequently occurring monthly level) is 65dBL_{Aeq}. The site establishment works are expected to cause the worst-case noise levels of 72L_{Aeq} for one month.

9.5.12 During the evening and night-time, the construction of the connection tunnel is expected to cause the worst-case noise levels of 47dBL_{Aeq} and 40dBL_{Aeq} respectively.

9.5.13 The construction noise levels are not estimated to exceed the potential significance criteria during the evening and night time. But the construction noise levels are estimated to exceed the potential significance criteria during the daytime for one month. During the remainder of the construction period the noise levels would be below the potential significance criteria.

9.5.14 Given the small magnitude that the potential significance criteria are exceeded by and the short duration, the effect is therefore assessed as **not significant**.

9.5.15 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.

83-87 Greenwich High Road (GP4)

9.5.16 83-87 Greenwich High Road is a four storey building. The first floor and above would be partially screened from the site offices, the workers entrance and the car park, and it would be entirely screened from the shaft site by the pumping station building and from the materials handling area by the railway viaduct. It is situated at a distance of some 5m from the southern site boundary, and 130m from the shaft itself. The predicted noise levels at these dwellings due to construction activities are shown in Vol 24 Table 9.5.1.

9.5.17 The typical daytime noise levels (most frequently occurring monthly level) is 61 dBL_{Aeq}. The site establishment works are expected to cause the worst-case noise level of 67 dBL_{Aeq} for one month.

9.5.18 During the evening and night-time, the construction of the connection tunnel is expected to cause the worst-case noise levels of 50dBL_{Aeq} and 41dBL_{Aeq} respectively.

9.5.19 The construction noise levels are not estimated to exceed the potential significance criteria during the evening and night-time. But the construction noise levels are estimated to exceed the potential significance criteria during the daytime for one month. During the remainder of the construction period the noise levels would be below the potential significance criteria.

9.5.20 Given the small magnitude that the potential significance criteria are exceeded by and the short duration, the effect is therefore assessed as **not significant**.

9.5.21 Other residential receptors such as the Jubilee on Egerton Drive lie further away from the site and site-based construction noise levels would be lower at these locations. Those residences on Greenwich High Road would additionally benefit from more screening than the development at 83-87 Greenwich High Road. As such, the impact to these receptors is also considered not significant.

9.5.22 The Millers Public House on Greenwich High Road is also located further from the development and would be screened by buildings in the 43-81 Greenwich High Road development. The impact from noise at this location would therefore be lower than that assessed at 83 -87 Greenwich High Road, and the effect would be not significant.

The Movement (GP6)

9.5.23 The Movement is a high-rise building, the upper floors of which would not be screened from the site. The Pumping Station building and railway viaduct would provide partial screening from the site offices and material handling area by the railway viaduct. It is situated at a distance of some 15m from the site boundary, and 40m from the shaft itself. The predicted noise levels at these dwellings at first floor and above due to construction activities are shown in Vol 24 Table 9.5.1.

9.5.24 The typical daytime noise levels (most frequently occurring monthly level) is 70dBL_{Aeq}. The construction of the shaft is expected to cause the worst-case noise level of 74dBL_{Aeq} for three months.

9.5.25 During the evening and night-time, the construction of the connection tunnel is expected to cause the worst-case noise levels of 55dBL_{Aeq} for both periods.

9.5.26 The construction noise levels are not estimated to exceed the potential significance criteria during the evening and night-time. But the construction noise levels are estimated to exceed the potential significance criteria during the daytime for seven months. During the remainder of the construction period the noise levels would be below the potential significance criteria.

9.5.27 As potentially significant effects have been identified for the daytime using the ABC criterion, noise levels within the rooms most exposed to the construction works have been estimated. This has been based on conservative assumptions regarding the noise transmission through the façade with the windows closed. The approach to estimating internal noise levels is described in the methodology in Volume 2. Secondary glazing/acoustic double glazing has been assumed for this receptor (based on the ambient noise level and planning requirements at the time of permissions). The estimation of internal noise levels also takes into account the glazed area of the façade and a typical reverberant characteristic for a domestic room.

9.5.28 The worst case internal noise level during the day is estimated to be 35dBL_{Aeq} for three months with windows closed or approximately 56dBL_{Aeq} if windows were opened on the most exposed facade. For the other months during which the potential significance threshold is exceeded, the internal noise levels is estimated to be 34dBL_{Aeq}. The worst-case internal level is estimated to be well below the internal guidance noise level of 40dBL_{Aeq} with windows closed, and it is estimated that the noise levels would not be excessive for speech communication if windows were partially open. This is therefore assessed as **not significant**.

9.5.29 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.

Rubicon (GP7)

9.5.30 The Rubicon is a high-rise building, the upper floors of which would not be screened from the materials handling area of the site. The Pumping Station building and railway viaduct would provide screening to the shaft construction area and site offices. It lies at a distance of some 50m from the site boundary, and 150m from the shaft itself. The predicted noise levels at these dwellings due to construction activities are shown in Vol 24 Table 9.5.1.

9.5.31 The typical daytime noise level (most frequently occurring monthly level) is 62dBL_{Aeq}. The worst-case noise level is also estimated to be 62dB$L_{Aeq.}$caused but the construction of the long connection tunnel to Chambers Wharf.

9.5.32 During the evening and night-time, the construction of the connection tunnel is expected to cause the worst-case noise levels of 52dBL_{Aeq} and 49dBL_{Aeq} respectively.

9.5.33 The construction noise levels are not estimated to exceed the potential significance criteria for a residential receptor. The effect is therefore assessed as **not significant**.

9.5.34 Adjacent to the Rubicon are other smaller residential buildings on Tarves Way, and the Hilton's Wharf Development on Norman Way. Northeast of these buildings are more residential buildings. As these buildings are further away from the site to the Rubicon and are screened by other buildings, and as such would be subject to lower noise levels than the Rubicon, the impact to these buildings is also considered to be not significant.

Paxton Point (GP8)

9.5.35 Paxton Point is a high-rise 11 storey building. The upper floors from the ninth floor and above would overlook the site, but are entirely screened from the site offices in the southern area of the development boundary, and also screened from the materials handling area to the north of the railway viaduct. The building is located 50m from the southern site boundary, and 190m from the shaft itself. Due to the height and location of the building, it would not be screened by the site hoardings. The predicted noise levels at these dwellings due to construction activities are shown in Vol 24 Table 9.5.1.

9.5.36 The typical daytime noise level (most frequently occurring monthly level) is 54dBL_{Aeq}. The shaft construction works are expected to cause the worst-case noise level of 64dBL_{Aeq}.

9.5.37 During the evening and night-time, the construction of the connection tunnel is expected to cause the worst-case noise levels of 42dBL_{Aeq} and 41dBL_{Aeq} respectively.

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

9.5.39 To the southwest of Paxton point lie sensitive non-residential receptors at Lewisham College and the Premier Inn London Greenwich, and residential properties on Greenwich High Road. These are further from the site than Paxton Point, are screened by the development at 43-81 Greenwich High Street and subject to additional existing noise sources (DLR) compared to Paxton Point. As such the effects to these receptors are also considered not significant.

Impacts at non-residential receptors

9.5.40 The results for non-residential receptors are shown below.

Vol 24 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}
GP3 Block E	Medium	52 – 72 (day)	61	65	61	+11
		52 – 52 (eve)	58	52	0	-6
		39 – 41 (night)	54	41	0	-13
GP5 Norman House	Medium	47 – 70 (day)	63	62	10	+7

[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

Block E (GP3)

9.5.41 Block E in the 41-83 Greenwich High Road development is approximately 5m from the southern boundary of the works. The upper floors of this building would be hotel rooms and due to the height of the building would not be screened from the southern half of the site. The building would be screened from the works around the shaft by the existing pumping station, and from the activities to the north by the DLR and railway viaducts.

9.5.42 The typical daytime noise level (most frequently occurring monthly level) is 65dBL_{Aeq}. The worst-case daytime noise level shown in Vol 24 Table 9.5.2 would occur during the site establishment works for approximately one month. The worst-case noise level of 72dBL_{Aeq} during the daytime is greater than the current ambient noise level for the daytime period. Other than the worst-case month, the noise highest levels would be much closer to the typical daytime noise level (ie, modal average).

9.5.43 During the evening and night-time, the construction of the connection tunnel is expected to cause the worst-case noise levels of 52dBL_{Aeq} and 41dBL_{Aeq} respectively (well below ambient levels).

9.5.44 Given the likely noise transmission to the building interior for a typical month of construction, the level of noise exceedance above the ambient noise level and the duration; this is assessed as **not significant**.

Norman House (GP5)

9.5.45 The Norman House office building is approximately 5m from the boundary of the works.

9.5.46 The typical daytime noise level (most frequently occurring monthly level) is 62dBL_{Aeq}. The worst-case daytime noise level shown in Vol 24 Table 9.5.2 would occur during the shaft construction for approximately four months. The noise level of 70dBL_{Aeq} at first floor and above during the daytime is greater than the current ambient noise level for the daytime period.

9.5.47 Although the noise level would increase relative to the ambient noise level and this could be noticeable inside the building, the increase in average noise levels inside the building is not expected to exceed guideline noise levels for general office use based on typical noise insulation for a façade of this type.

9.5.48 Given the sensitivity of the receptor and the duration of the impact, construction noise at this receptor has been assessed as **not significant**.

9.5.49 The Brookmarsh Industrial Estate is located to the northern boundary of the site, and the Faircharm Trading Estate to the northwest. These are both industrial estates which are of low sensitivity to noise and as such the impact on these estates would be not significant.

Road-based construction traffic

9.5.50 The location of the site at Greenwich Pumping Station 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 77 heavy vehicles (HGVs) (equivalent to 154 movements) per day.

9.5.51 The major road links adjacent to and leading to the site are Norman Road, Greenwich High Road and Creek Road. Vehicles would not use local roads, such as Tarves Way, to access the site.

9.5.52 The traffic modelling shows that the 18hr Annual Average Weekday Traffic (AAWT) flow on the section of Greenwich High Road to the West of Norman Road, which is adjacent to the site, is currently approximately

8,000 vehicles per day (vpd), with average speeds of 13.4 mph (22 kph) and 6.2% HGVs. The total number of HGVs is therefore currently 496 per day.

9.5.53 The section of Creek Road which is to the north of the site has the highest flow, with just below 25,000 vpd and 5.1% HGVs. The flow on the remaining links is substantially lower than that on Creek Road, with flows on other links being approximately 10,000 vpd or less. The majority of links have similar HGV percentages, although the section of Creek Road to the northeast of the site has a significantly higher percentage of HGVs of 11.4%.

9.5.54 The modelling of construction traffic on these links shows that the highest percentage increase in total flow due to construction HGVs would occur on the section of Greenwich High Road to the West of Norman Road. The average daily number of construction HGVs on this link during the peak month of construction is 154 and the daily number of worker cars and office/operational light vehicles is 14. This represents a percentage increase in flow of approximately 2% and represents an increase in HGV composition of 1.7%.

9.5.55 Therefore, the percentage flow change and change in HGV percentage do not meet the criteria for causing a 1dB change in noise level. The impact of road-based construction traffic on nearby receptors is considered to be **not significant**.

Vibration

9.5.56 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.

9.5.57 The assessment has been conducted using the methodology defined in Volume 2.

9.5.58 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 24 Table 9.5.3.

Vol 24 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
GP1	Hatfield House - 43-81 Greenwich High Road	<0.2	High	Low probability of adverse comment - No impact

Ref	Receptor	Impact (highest predicted eVDV across all activities, $m/s^{1.75}$)*	Value/ sensitivity	Magnitude
GP2	Torrent Lodge - 43-81 Greenwich High Road	<0.2	High	Low probability of adverse comment - No impact
GP3	Block E - 43-81 Greenwich High Road	<0.2	Medium	Below Low probability of adverse comment - No impact
GP4	83-87 Greenwich High Rd	<0.2	High	Low probability of adverse comment - No impact
GP5	Norman House	<0.3	Medium	Below Low probability of adverse comment - No impact
GP6	The Movement	<0.5	High	Impact – Adverse comment possible
GP7	Rubicon	<0.2	High	Low probability of adverse comment - No impact
GP8	Paxton Point - 43-81 Greenwich High Road	<0.2	High	Low probability of adverse comment - No impact

Most affected floor

9.5.59 All of the predicted eVDV levels at each of the receptor locations fall within or below the 'Low probability of adverse comment' band, as described in Volume 2 except for The Movement where vibration levels due to vibratory compaction fall into the "Adverse comment possible" band. However the activity which results in this level occurs for less than 1 week and therefore a significant effect is not identified at this location.

9.5.60 Significant effects are not anticipated at other receptors. These predicted levels are based upon the highest anticipated exposures during the most intense vibration activities within the site.

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 24 Table 9.5.4.

Vol 24 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
GP1	Hatfield House - 43-81 Greenwich High Road	<0.5	High	Below threshold of potential cosmetic damage - No impact
GP2	Torrent Lodge - 43-81 Greenwich High Road	<0.5	High	Below threshold of potential cosmetic damage - No impact
GP3	Block E - 43-81 Greenwich High Road	<0.5	Medium	Below threshold of potential cosmetic damage - No impact
GP4	83-87 Greenwich High Rd	<0.5	High	Below threshold of potential cosmetic damage - No impact
GP5	Norman House	<3.0	Medium	Below threshold of potential cosmetic damage - No impact
GP6	The Movement	<0.5	High	Below threshold of potential cosmetic damage - No impact
GP7	Rubicon	<0.5	High	Below threshold of potential cosmetic

Ref	Receptor	Impact (highest predicted PPV across all activities, mm/s)	Value/ sensitivity	Magnitude
				damage - No impact
GP8	Paxton Point - 43-81 Greenwich High Road	<0.5	High	Below threshold of potential cosmetic damage - No impact

9.5.62 The vibration levels reported here are well below the levels likely to cause cosmetic building damage according to the criteria described in Volume 2.

9.5.63 Vibration effects to all receptors for either human disturbance or cosmetic damage are assessed as **not significant**.

Sensitivity test for programme delay

9.5.64 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 24 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 Greenwich Pumping Station is the drive shaft site for the Greenwich connection tunnel, where an active ventilation system would be installed within the existing East Beam Engine House building. Preliminary noise predictions for these arrangements have been carried out and the design of the systems has included noise control measures which ensure that noise levels are controlled to be within the noise limits identified by RB of Greenwich (see para.9.3.16).

9.6.3 The main plant would include centrifugal fans, which would draw air through carbon filters before discharging through outlet ducts at the top of the adjacent vent stack. The noise assessment is based on the ventilation fans being housed within the East Beam Engine House building and includes all aspects of noise generation such as plant noise and wind noise through ducts and vent columns.

9.6.4 The noise emission predictions have been based on data for typical plant at the appropriate operating settings. FläktWood's HCGB 080 centrifugal fans at a pressure drop of 1170Pa and a speed of 1500rpm have been used.

9.6.5 It is shown from noise prediction studies of the plant and buildings, that there is sufficient potential to limit noise emissions so that receptor noise level limits are met.

9.6.6 From the noise predictions, necessary noise control measures include duct attenuators for exhaust ducts. The fans would require an acoustic enclosure to ensure noise break-out from the building facade is minimized.

9.6.7 The prediction method and assumptions are described in Volume 2. Vol 24 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 24 Table 9.6.1 Noise – operational airborne noise impacts

Ref	Receptor	Lowest baseline noise level	Impact	Value/ sensitivity	Magnitude
GP 1	Hatfield House - 43-81 Greenwich High Road	43dB$L_{A90,}$ 15 minutes	Plant noise emission rating level at receptor less than 33dB$L_{Ar,Tr}$	High	Plant noise level below local authority limit*,– no adverse impact
GP 2	Torrent Lodge - 43-81 Greenwich High Road	43dB$L_{A90,}$ 15 minutes	Plant noise emission rating level at receptor less than 33dB$L_{Ar,Tr}$	High	Plant noise level below local authority limit*,– no adverse impact
GP 3	Block E - 43-81 Greenwich High Road	54dB$L_{Aeq,}$ 15 minutes	Plant noise emission rating level at receptor less than 54dBL_{Aeq}	High	Plant noise level below ambient night level – no adverse impact
GP 4	83-87 Greenwich High Rd	44dB$L_{A90,}$ 15 minutes	Plant noise emission rating level at receptor less than 34dB$L_{Ar,Tr}$	High	Plant noise level below local authority limit*,– no adverse

Ref	Receptor	Lowest baseline noise level	Impact	Value/ sensitivity	Magnitude
					impact
GP 5	Norman House	63dB$L_{Aeq,\ 1\ hour}$	Plant noise emission level at receptor less than 63dBL_{Aeq}	Medium	Plant noise level below ambient evening level – no adverse impact
GP 6	The Movement	44dB$L_{A90,\ 15\ minutes}$	Plant noise emission rating level at receptor less than 34dB$L_{Ar,Tr}$	High	Plant noise level below local authority limit*,– no adverse impact
GP 7	Rubicon	44dB$L_{A90,\ 15\ minutes}$	Plant noise emission rating level at receptor less than 34dB$L_{Ar,Tr}$	High	Plant noise level below local authority limit*,– no adverse impact
GP 8	Paxton Point - 43-81 Greenwich High Road	44dB$L_{A90,\ 15\ minutes}$	Plant noise emission rating level at receptor less than 34dB$L_{Ar,Tr}$	High	Plant noise level below local authority limit*,– no adverse impact

**Limit referred to is that identified for the Local Authority in which the receptor is located (see para. 9.3.16)*

9.6.8 The results given above in Vol 24 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

9.6.9 Measurements taken during storm and non-storm events at operational drop structures in the United States, equivalent to those being considered for the Thames Tideway Tunnel, have been used to inform the assessment of noise and vibration during tunnel filling events. These studies (Jain, SC and Kennedy, JF, 1983)[4], are described in Vol 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.

9.6.10 These events are not typical and only occur during severe rain storms. At Greenwich Pumping Station, 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.

9.6.11 The highest 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.

9.6.12 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

9.6.13 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.

9.6.14 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.

9.6.15 As no impacts have been identified from the operation of the site, this is assessed as **not significant**.

Noise from operational traffic

9.6.16 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.

9.6.17 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

9.6.18 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 24 Appendix N), there would be no new receptors, within the assessment area, requiring assessment as a result of a one year delay.

9.7 Cumulative effects assessment

Construction effects

9.7.1 Of the projects described in Section 9.3, the construction of Creekside Village East is considered relevant to the construction cumulative assessment at Greenwich Pumping Station as the development would be under construction at the same time as the Thames Tideway Tunnel.

9.7.2 Cumulative noise effects are not considered likely at receptors south of the DLR railway, owing to the reduction in construction noise due to increased distance from the Thames Tideway Tunnel and Creekside Village East sites. At the Rubicon, noise levels from Greenwich Pumping Station during the day and evening are well below the impact criterion. Given that Creekside Village East is unlikely to require night-time working, cumulative night time noise effects are not predicted.

9.7.3 Cumulative vibration effects are not predicted due to the distance between this site and the high vibration activities. This would also be the case if the programme for the Thames Tideway Tunnel project was delayed by approximately one year.

Operational effects

9.7.4 None of the projects described in Section 9.3 are considered relevant to the operational cumulative assessment at Greenwich Pumping Station 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 no significant adverse noise or vibration effects during the construction phase. As such, no further mitigation is required.

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 further mitigation measures are proposed beyond the measures set out in the *CoCP*, the residual construction effects remain as presented in Section 9.5*.*

Operational effects

9.9.2 As no mitigation measures are required, the residual operational effects remain as presented in Section 9.6.

9.10 Assessment summary

Vol 24 Table 9.10.1 Noise – summary of construction assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Surface construction noise				
GP1 - Hatfield House - 43-81 Greenwich High Road	Noise	Not significant	None	Not significant
GP2 - Torrent Lodge - 43-81 Greenwich High Road	Noise	Not significant	None	Not significant
GP3 - Block E - 43-81 Greenwich High Road	Noise	Not significant	None	Not significant
GP4 - 83-87 Greenwich High Rd	Noise	Not significant	None	Not significant
GP5 - Norman House	Noise	Not significant	None	Not significant
GP6 - The Movement	Noise	Not significant	None	Not significant
GP7 - Rubicon	Noise	Not significant	None	Not significant
GP8 - Paxton Point - 43-81 Greenwich High Road	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

Vol 24 Table 9.10.2 Vibration – summary of construction assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
GP1 - Hatfield House - 43-81 Greenwich High Road	Vibration	Not significant	None	Not significant
GP2 - Torrent Lodge - 43-81 Greenwich High Road	Vibration	Not significant	None	Not significant
GP3 - Block E - 43-81 Greenwich High Road	Vibration	Not significant	None	Not significant
GP4 - 83-87 Greenwich High Rd	Vibration	Not significant	None	Not significant
GP5 - Norman House	Vibration	Not significant	None	Not significant
GP6 - The Movement	Vibration	Not significant	None	Not significant
GP7 - Rubicon	Vibration	Not significant	None	Not significant
GP8 - Paxton Point - 43-81 Greenwich High Road	Vibration	Not significant	None	Not significant

Vol 24 Table 9.10.3 Noise – summary of operational assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
GP1 - Hatfield House - 43-81 Greenwich High Road	Noise	Not significant	None	Not significant
GP2 - Torrent Lodge - 43-81 Greenwich High Road	Noise	Not significant	None	Not significant
GP3 - Block E - 43-81 Greenwich High Road	Noise	Not significant	None	Not significant
GP4 - 83-87 Greenwich High Rd	Noise	Not significant	None	Not significant
GP5 - Norman House	Noise	Not significant	None	Not significant
GP6 - The Movement	Noise	Not significant	None	Not significant
GP7 - Rubicon	Noise	Not significant	None	Not significant
GP8 - Paxton Point - 43-81 Greenwich High Road	Noise	Not significant	None	Not significant

Vol 24 Table 9.10.4 Vibration – summary of operational assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
GP1 - Hatfield House - 43-81 Greenwich High Road	Vibration	Not significant	None	Not significant
GP2 - Torrent Lodge - 43-81 Greenwich High Road	Vibration	Not significant	None	Not significant
GP3 - Block E - 43-81 Greenwich High Road	Vibration	Not significant	None	Not significant
GP4 - 83-87 Greenwich High Rd	Vibration	Not significant	None	Not significant
GP5 - Norman House	Vibration	Not significant	None	Not significant
GP6 - The Movement	Vibration	Not significant	None	Not significant
GP7 - Rubicon	Vibration	Not significant	None	Not significant
GP8 - Paxton Point - 43-81 Greenwich High Road	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] 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).

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

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Volume 24: Greenwich Pumping Station site assessment

Section 10: Socio-economics

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Thames Tideway Tunnel

Environmental Statement

Volume 24: Greenwich Pumping Station 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 Greenwich Pumping Station site. At this site effects during construction are considered on the businesses that currently exist on the proposed construction and on the amenity of nearby residents and hotel businesses.

10.1.2 At this site, operational effects have not been assessed as the design, size, and location of the proposed operational phase structures would result in the permanent take up of less than 0.1ha and would only partly restrict the site development options. Therefore, it would not be likely to result in any significant loss of function for employment generating activities in the project's operational phase. As no significant operational effects are considered likely only information relating to construction is presented in the assessment of socio-economic effects.

10.1.3 The likely significant project-wide socio-economic effects, including employment generation, stimulation of industry, and leisure, recreation and health related effects on users of the River Thames are described in Volume 3 Project-wide effects assessment.

10.1.4 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.

10.1.5 Plans of the proposed development as well as figures included in the assessment for this site are contained in a separate volume (Volume 24 Greenwich Pumping Station Figures).

10.1.6 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 The proposed development would partly take place within a Thames Water site, occupied by Greenwich Pumping Station, and partly on land currently occupied by a builders' merchant business and a vacant open storage yard (which was vacated in March 2012).

10.2.3 A public footpath, which runs from Norman Road to Creekside, would be diverted approximately 10m to the north along the southern side of the railway embankment during the construction works. No significant effects are considered likely to arise from this diversion and as such no assessment is warranted.

10.2.4 Works at the site are expected to last approximately five and a half years. See Section 3.3 of this volume for further details of the construction working hours.

10.2.5 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

10.2.6 The construction site is expected to require a maximum workforce of approximately 165 workers at any one time (ie, during the daytime shift). It is noted that the table shows the maximum number of workers required (289), however, as a result of shift patterns the maximum workforce on site would be 165 occurring during the dayshift (08:00-18:00). The number and type of workers is shown in Vol 24 Table 10.2.1.

Vol 24 Table 10.2.1 Socio-economics – construction worker numbers

Contractor					Client	
Staff*		Labour**			Staff***	
08:00-18:00	18:00-08:00	08:00-15:00	15:00-23:00	23:00-08:00	08:00-18:00	18:00-08:00
60	15	60	60	45	45	4

**Staff Contractor – engineering and support staff to direct and project manage the engineering work and site.*
***Labour – those working on site doing engineering, construction and manual work.*
****Staff Client – engineering and support staff managing the project and supervising the Contractor.*

Code of Construction Practice

10.2.7 Measures incorporated into the *Code of Construction Practice (CoCP) Part A* to limit significant adverse air quality, construction dust (Section 7), noise, vibration (Section 6), and visual impacts (Section 4) would help to avoid socio-economic effects, particularly amenity effects.

10.2.8 The *CoCP Part A* 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[i] and the local authority where required. This would be in

[i] 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.

accordance with the *Ecology and landscape management plan* and the approved landscape design for the site (see Section 4 within the *CoCP* Part A).

10.2.9 Further site specific measures, which could reduce socio-economic effects and particularly amenity effects, are incorporated into the *CoCP Part B*. See the *CoCP* sections in the air quality and odour, noise and vibration, and townscape and visual assessments (Sections 4.2, 9.2 and 11.2 respectively within this volume) for details on the type of measures that would be employed.

10.2.10 The *CoCP Part B* makes provision for the existing public footpath from Norman Road (B208) to Creekside will be realigned, and suitable access for disabled users will be maintained, unless agreed otherwise (see Section 5 within the *CoCP Part B*).

10.3 Assessment methodology

Engagement

10.3.1 Vol 2 of this assessment documents the overall engagement process which has been undertaken in preparing the *Environmental Statement*. There are no site specific comments from consultees for this site relating to socio-economics.

Baseline

10.3.2 The baseline methodology follows the standard methodology provided in Vol 2 Section 10.5. There are no site specific variations for this site.

Construction

10.3.3 For this site, the base case is the peak year of construction works. The assessment area is as set out in Vol 2 Section 10.5.

10.3.4 The assessment methodology for the construction phase follows that described in Vol 2 Section 10.5. There are no site specific variations for undertaking the construction assessment for this site.

10.3.5 Section 10.5 details the likely significant effects arising from the construction at the Greenwich Pumping Station site. There are no other Thames Tideway Tunnel project sites which could give rise to additional effects on socio-economics within the assessment area for this site, therefore no other Thames Tideway Tunnel project sites are considered in this assessment.

10.3.6 Of the developments listed in the site development schedule (see Vol 24 Appendix N), the developments which are considered relevant as receptors for the construction base case assessment are:

a. 43-81 Greenwich High Road – providing for change of use to allow for a 68 room hotel in place of commercial and residential uses

b. 83-87 Greenwich High Road – including commercial and residential floorspace

c. Greenwich Industrial Estate redevelopment – including commercial, hotel, community and residential floorspace and public realm improvements

d. Hilton's Wharf – including commercial, live work, residential floorspace and open space

e. Site of old Seagar Distillery and Norfolk House – including commercial and residential floorspace

10.3.7 These developments are relevant to the amenity effect assessments that have been undertaken as part of this socio-economic assessment. This is because they would be fully complete and operational by the base case, thereby altering the existing baseline by replacing much of the existing and former employment land uses with residential led mixed use development. This would increase the number of potentially sensitive receptors, including residential and hotel businesses within 250m of the site (ie, the assessment area for amenity effects as set out in Vol 2 Section 10.5).

10.3.8 Of the developments listed in the site development schedule (see Vol 24 Appendix N), one, Creekside Village East, has been considered in the construction assessment for cumulative effects. This development would be under construction at the same time as the Thames Tideway Tunnel construction works in the peak year at the Greenwich Pumping Station site. Therefore it could give rise to cumulative amenity effects with the construction of the Thames Tideway Tunnel project on nearby sensitive receptors.

10.3.9 The other development in the Development Schedule (Vol 24 Appendix N) that would also be under construction is outside of the assessment area screening distance of 250m and are therefore it is not considered in the cumulative effect assessment.

10.3.10 The assessment of construction effects also considers the extent to which the effects on socio-economics 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

10.3.11 The assumptions and limitations associated with this assessment are presented in Vol 2 Section 10.5.

Assumptions

10.3.12 The following assumption is specific to the assessment of this site: the currently vacant open storage yard would either remain vacant and unused in the construction base case year or that any occupiers would be short-term.

Limitations

10.3.13 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 area within 250m of the site comprises a mix of residential and commercial uses, and a range of community facilities. Residential dwellings, found mostly to the west, south and southwest, comprise a mix of newer and older terraced houses, as well as purpose built, mostly low rise flats (see Vol 24 Figure 2.1.2 in separate volume of figures). Of the commercial land uses, industrial premises are located to the west and northwest of the site, along the banks of Deptford Creek, and to the north along Norman Road. However, much of this development is in the process of being converted to residential led mixed land uses.

Community profile

10.4.3 A detailed community profile is outlined in Vol 24 Appendix H.1[ii]. The following points provide a summary of the community profile and provide context for this socio-economic assessment:

a. The resident population was approximately 2,075 within 250m of the site at the time of the last census for which data is available[iii].

b. The proportion of under 16 year olds and over 65 year olds within 250m of the site (19.3% and 11.2% respectively) is slightly lower than within the Royal Borough (RB) of Greenwich and Greater London.

c. Within 250m, White residents comprise over two thirds of the resident population (69.1%), below the level recorded within the RB of Greenwich (77.1%) but closer to the Greater London average (71.2%).

d. Within 250m, Black residents (20.5%) account for almost double the proportion of residents as within both the RB of Greenwich and Greater London (11.1% and 10.9% respectively).

e. In contrast, within 250m, Asian residents (3.7%) account for approximately half that within the RB of Greenwich level and a quarter of that within Greater London.

f. The proportion of residents within 250m of the site that have a long term or limiting illness (14.7%) is slightly below both the RB of Greenwich and Greater London average levels.

g. The proportion of residents who claim disability living allowance within 250m (5.5%) is slightly lower than the RB of Greenwich proportion, but approximately one fifth higher than the Greater London level.

[ii] Information sources are provided in the appendix.

[iii] Census 2001. This type of data for the 2011 Census had not been released at the time of the assessment.

h. General health in the local area is mixed, with low life expectancy, and higher rates of death from cancer but lower rates of death from circulatory disease relative to Greater London.

i. The incidence of income deprivation within 250m of the site (38.4%) is somewhat lower than for the RB of Greenwich overall. However, it is almost one third higher than the Greater London average. Overall deprivation within 250m (38.4%) is slightly lower than within the RB of Greenwich but 50% higher than across Greater London.

10.4.4 The above community profile suggests that the local community is quite diverse with slightly below average proportions of both children and elderly residents. The community as a whole has low life expectancy and experiences moderate levels of deprivation.

10.4.5 As outlined in para. 10.3.6, it is noteworthy that the area within 250m of the site is currently subject to several development projects. As such, it can be expected that the demographic profile within this area would change in the years leading up to construction. At this stage it is not known how the community profile of the area will change.

Economic profile

10.4.6 A local economic profile (based on 2012 data) is presented in Vol 24 Appendix H.2. The following points provide a summary of the profile and provide context to this socio-economic assessment:

a. Within approximately 250m of the site there are approximately 2,200 jobs and 350 businesses[iv].

b. The three largest employment sectors as measured by employment within approximately 250m are: Professional, Scientific and Technical Activities; Accommodation and Food Service Activities; and Other Service Activities.

c. The three largest employment sectors as measured by number of businesses at locations / units within approximately 250m are: Professional, Scientific and Technical Activities; Administrative and Support Service Activities; and Wholesale and Retail Trade / Repair of Motor Vehicles and Motorcycles.

d. At all geographical levels most businesses fall within the smallest size band (one to nine employees). There is a slightly greater proportion of small (ten to 49 employees) and medium size businesses (50 to 249) within approximately 250m businesses than within the RB of Greenwich and Greater London as a whole.

e. Businesses within the micro size band also account for the majority within each of the leading sectors within 250m. There is a slightly

[iv] Source: Experian 2012. Data is aggregated for seven digit post-code units falling wholly or partially within a 250m 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. Businesses as defined here include private sector, public sector and voluntary / charitable entities.

greater proportion of small (ten to 49 employees) and medium sized businesses (50 to 249 employees) within the Accommodation and Food Service Activities sector compared with the other sectors.

Receptors

Business – builders' merchant

10.4.7 The northern part of the site, beyond the railway embankment, is occupied by a builders' merchant business which sells to the building trade and general public. The number of employees at the business is not known precisely although it is understood that it employs up to 20 people. The business occupies a site measuring approximately 0.5ha in size. The business is part of a company that has operations at other sites as well as at this location.

10.4.8 Vol 24 Figure 10.4.1 (see separate volume of figures) shows the location of this receptor.

10.4.9 The main factors affecting the sensitivity of the business to displacement of their activities are:

a. It is assumed that the nature of the activities taking place on site are such that they could be replicated at other industrial and warehousing premises within the RB of Greenwich or in the wider Greater London area.

b. In terms of available alternative premises, Valuation Office Agency (VOA, 2012)[2] data indicates that in 2006, 8% of the total industrial and warehousing floorspace stock in the borough was vacant, which was lower than the London average at the time (11%). For the neighbouring London Borough (LB) of Lewisham, 13% of such floorspace was vacant in the same year (the latest date for which data at these spatial geographies have been published). Data from autumn 2011 for southeast London and Kent indicates that vacancy rates for such floorspace are approximately 7% as a whole (Glenny, 2011)[3], having increased by over 50% from 4.5% in spring 2007 (Glenny, 2011)[4]. Given the current state of the economy, it is expected that net absorption of vacant industrial and warehousing floorspace by the market over coming years will be relatively slow. However it is understood that vacancy rates for sites of the size occupied by the builder's merchant are lower than overall vacancy rates.

c. It is assumed that the business (which is engaged in construction related activities) derives some benefit from its existing location, given the scale of physical redevelopment, and hence construction works, taking place in the Deptford Creekside area.

d. Although the business in question caters to a specific type of retail sector, it is considered that the business is not unique. Further, given the sector and skills involved, it is assumed that employees would be able to transfer to alternative sources of employment relatively easily.

10.4.10 On the basis of the factors considered above the sensitivity of the business to disruption or displacement of its activities is considered to be medium.

Residential

10.4.11 There are existing and base case residential developments near the proposed construction site, as identified in the air quality and odour, noise and vibration and townscape and visual assessments.

10.4.12 Land that is predominantly used for residential development is shown in the land use plan for this site, see Vol 20 Figure 2.1.2 (separate volume of figures).

10.4.13 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.

10.4.14 Therefore, as outlined in the methodology for this socio-economic impact assessment (see Vol 2 Section 10.5) the sensitivity of nearby residential receptors to amenity impacts would be medium during the day and evening and high during the night.

Business – Hotel

10.4.15 An hotel, with approximately 150 beds, is located approximately 60m southeast of the site at 43 – 81 Greenwich High Road. The hotel ranges between five and eight storeys in height, including the ground level. The number of employees at the business is not known. However, the number of employees can be estimated based on the number of bedrooms within the hotel by using the Homes and Communities Agency (HCA)'s benchmark average employment densities (Homes and Communities Agency, 2010)[5]. Accordingly, it is estimated that the level of employment typically generated by a hotel of this size and standard would be equivalent to approximately 50 employees[v], plus additional casual staff, meaning the hotel on this site would equate to either a small size (ie, ten to 49 employees) or medium size (ie, 50 to 249 employees) enterprise.

10.4.16 Vol 24 Figure 10.4.1 (see separate volume of figures) shows the location of this receptor.

10.4.17 The main factors affecting the sensitivity of the hotel business are:

a. The hotel is located at the far end of a relatively dense development and it is relatively well screened from the Greenwich Pumping Station site by other comparably sized buildings.

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[v] The HCA benchmark employment densities provide an estimate of full time equivalent employment, and the density that has been used is based on a 'budget' hotel classification. They also indicate that there would be additional casual employment in addition to this number of employees, however no method is provided for estimating the number of casual employees.

b. Given the location and the type of hotel, most customers of the hotel are likely to be overnight guests and use of the hotel during the daytime is likely to be relatively limited.

c. If customers were sufficiently deterred from staying at the hotel by amenity impacts such as noise, dust or unpleasant views, then the hotel would in turn suffer deterioration in trade, which in turn could lead to a reduction in the number of employees required by the hotel.

d. In terms of the sensitivity of the hotel'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 (People1st, 2011)[6]. Accordingly, it is considered that hotel employees typically find it easier to access alternative employment opportunities elsewhere.

10.4.18 On the basis of the factors considered above, including the nature of the hotel, its location, and its likely clientele base, it is considered that the overall sensitivity of the hotel to amenity impacts would be medium.

Summary

10.4.19 A summary of receptors as described in the baseline and their sensitivity is provided in Vol 24 Table 10.4.1.

Vol 24 Table 10.4.1 Socio-economics – receptors / sensitivities

Receptor	Value / sensitivity and justification
Business – builders' merchant	Medium – Limited supply of alternative potential premises within the borough but wider supply available within neighbouring boroughs and southeast of London; the business would likely derive some benefit from the location given their nature and the scale of development taking place in the local area now and leading up to the base case. The business and employment provided by it are not highly specialised or unique.
Residents	Medium / High – residents would have limited opportunity to avoid effects. They would have medium sensitive to amenity effects overall during the day but would have high sensitivity to amenity effects overall during the evening and night.
Business – hotel	Medium – if customers were sufficiently deterred from staying at the hotel by amenity impacts then the hotel could suffer deterioration in trade, which could in turn affect employees. The hotel sector however typically experiences relatively high staff turnover.

Construction base case

10.4.20 The construction assessment year and area are as set out in para. 10.3.3.

10.4.21 The construction base case takes into account new developments that would be completed and partially or fully operational by the peak construction year.

10.4.22 The base case in the peak year of construction, taking into account the schemes described in para. 10.3.6, would differ from the baseline in the following ways:

a. It would include additional residential receptors that could potentially be affected by amenity impacts arising from the proposed development. These new residential receptors are identified in the air quality, noise and vibration and visual assessments.

b. The addition of three potentially sensitive business receptors within 250m of the site:

i The development at 43 – 81 Greenwich High Street (which already contains a 150 room hotel as identified in para. 10.4.15) would include a second hotel, containing 68 rooms, and located adjacent the site to the south with rooms overlooking the proposed construction site to the north and also overlooking Greenwich high Road to the south).

ii The residential-led development at Greenwich Industrial Estate would include two hotels. The proposed hotels would be a 104 bed at the far end of the residential-led development and a four storey 30 room on the north east corner of Greenwich High Road and Norman Road.

iii It is considered that these hotels, as businesses, would have the same level of sensitivity to amenity effects as the existing hotel located south of the site, ie, medium (see para. 10.4.15 and para. 10.4.18).

10.4.23 It is possible that businesses in the local area may change with premises being occupied and vacated, including the open storage yard within the site area. However, it is not possible to forecast these changes with accuracy.

10.4.24 None of the developments listed above directly affect the builders' merchant business currently located at the site. As such, it is considered that this business would be present in the base case as it is in the existing baseline.

10.5 Construction effects assessment

Displacement of business – builders' merchant

10.5.1 The construction works would result in the displacement of the builders' merchant business at the site.

10.5.2 The magnitude of the impact is influenced by the following factors:

a. Although the construction is temporary, the displacement and impact for the business would most likely mean that once settled at new premises, the business would probably not choose to return to the existing site.

b. An alternative location for the business has not yet been identified. Although overall vacancy rates in the wider region are moderate, it is understood that the availability of larger sites (such as that occupied by the builders' yard) is lower and a comparable alternative may therefore be more difficult to secure. However, as part of a larger chain of stores, the company operating the business may also choose to consolidate operations within other branches within southeast London.

c. While the business may derive some benefit from their location at this site, they may be able to 'carry' its customers to a new location within the RB of Greenwich or the southeast region of London.

d. The builders' merchant businesses currently on site is a small size enterprise, based on the number of employees that it is estimated to employ (see para. 10.4.7).

e. 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, temporary loss of profits during the period of the move, and diminution of goodwill following the move (reflected in reduced profits). If the business became extinguished as a result of the relocation, its employees could potentially lose their jobs.

f. 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 programme, it is assumed for the purposes of this assessment that reasonable costs and expenditure incurred in association with relocation would be met.

g. There is a possibility that, despite the availability of compensation, the requirement to relocate could result in the extinguishment of the business because it would not be economically viable for it to relocate. However, it has been considered for the purposes of this assessment that this scenario is unlikely given the assumed sensitivity of the business at this site.

10.5.3 Taking account of the above, it is assessed that the magnitude of the impact arising from the relocation of the business to a new location would be low.

10.5.4 Given the low magnitude of the impact and the medium sensitivity of the receptor, it is assessed that there would be a **minor adverse** effect on the business and the employment provided by the business.

Effect on the amenity of residents

10.5.5 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, 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 nearby residential receptors:

a. Local air quality effects would be **minor adverse** at the eight residential receptors identified. Construction dust effects would be **minor adverse** at two receptors and **negligible** at the remaining six receptors.

b. Noise effects on residents would be **not significant** during the day at all of the six residential receptors identified. The construction noise levels are not estimated to exceed the potential significance criteria during the evening and night-time at any of the six receptors. In regard to road-based construction traffic, the noise assessment found that the additional numbers of HGVs would cause negligible change to the traffic noise levels and that the effects have been assessed as **not significant**. Vibration (human response) effects would be **not significant** at all six receptors.

c. During the day, visual effects would be **moderate adverse** at three viewpoints (1.2, 1.5 and 1.6) and **negligible** at the remaining three viewpoints (1.1, 1.3 and 1.4) identified. During the night, visual effects caused by the high visibility of capped and directional lighting would be **minor adverse** at two viewpoints (1.5 and 1.6) and **negligible** at the remaining four viewpoints.

10.5.6 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 and a half year construction programme, the effects noted above would be likely to be experienced over a long term period. The exceptions are:

   i Local air quality effects may not be minor adverse over the whole construction period as the assessment is based on the peak construction year and these effects may be negligible in other years.

   ii Significant visual effects caused by lighting are expected to occur over a medium rather than a long term period, given the timeframes during which extended and continuous working hours would apply as set out in Section 3.3 of this volume.

b. While it is estimated that there would be significant adverse visual effects during the day, it is considered that views from a residential property form one of many elements that contribute to the quality of a residential environment. Many of the dwellings at the receptors represented by this viewpoint are also likely to have views in other directions that are either not as severely affected or not affected at all.

10.5.7 On the basis of the above findings and factors, it is considered that the overall amenity impact magnitude would be low.

10.5.8 Taking account of the low magnitude of impact and the medium sensitivity of residents, it is considered that the effect on the amenity of a limited number of residential receptors would be **minor adverse**.

10.5.9 This assessment relates to those residential receptors that would experience adverse local air quality, construction dust and visual effects. When there are no such effects, or for residential receptors not subject to these effects, it is considered that there would be a lower effect on residential amenity.

Effect on hotel businesses due to construction activity

10.5.10 There would be four hotels located within 250m of the site in the base case. Effects on environmental amenity such as noise, dust or unpleasant views have the potential to deter hotel guests from staying at the hotel (and therefore result in a deterioration in business) and could also affect staff.

10.5.11 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 nearby hotels:

a. A local air quality assessment and construction dust assessment was undertaken for the proposed 68 room hotel (also referred to as Block E, 43 – 81 Greenwich High Road). This is the closest hotel to the proposed construction site of the four hotels that would exist in the base case. For this receptor, local air quality effects would be **negligible** and construction dust effects would be **minor adverse**. The other three hotels are located further from the proposed construction site than the hotel which was assessed. The construction dust assessment concludes that for receptors at distances greater than 20m from the site, the significance of effects would be **negligible** with the implementation of *CoCP* measures.

b. Noise and vibration effects would be **not significant** on the proposed 68 room hotel (also referred to as Block E, 43 – 81 Greenwich High Road). Noise and vibration effects were not assessed for the other three hotels which are all located further from the proposed construction site than the site which was assessed. Additionally, noise and vibration effects at all assessed residential receptors[vi], including those that are part of schemes within which the other three hotels are located, would be **not significant**.

c. Visual effects would be **moderate adverse** during the daytime at two viewpoints (1.5 and 1.6) which represent views from the residential developments which would include the four hotels and **minor adverse** at the same viewpoints during the night.

[vi] The assessment of residential receptors is a relevant proxy to examine, as the noise and vibration assessment methodology ascribes a higher sensitivity to residential receptors than to hotels.

10.5.12 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 and a half year construction programme, the effects noted above would be likely to be experienced for a long term period.

b. In relation to the position of the hotels, it is noteworthy that the two largest hotels are located at the far end of each of the two neighbouring developments (43 – 81 Greenwich High Road and The Movement), and as such are located further away from the site than the two smaller hotels. The results of the air quality and construction dust assessments demonstrate that the effects on sensitive receptors decline as the distance of the receptor from the site increases and that not all individually assessed receptors located closer to the site would experience significant adverse effects. This would actively limit the degree to which the two larger hotels in particular would be affected.

c. It is also considered that visual effects would decline with distance from the site. Many hotel rooms would also not face the site; and so any visual effects would only be experienced by a limited number of hotel guests.

d. Given the above results, and the location of the respective hotels, it is considered that bookings at the smaller hotels would be unlikely to be significantly affected by adverse amenity effects.

e. The two larger hotels would be even less likely to be significantly affected. This is due to the position of these hotels relative to the site, their larger size, and the fact they have more hotel rooms, which would afford them more options to manage bookings and position guests away from the most affected façades. These factors would be likely to minimise the effect on these two larger businesses.

10.5.13 On the basis of the above findings and factors, it is considered that the overall magnitude of impact on the four hotel businesses near the site from the downturn in trade could be low.

10.5.14 Taking account of the low magnitude of impact and the medium sensitivity of the hotel businesses, it is considered that the effect on the businesses be **minor adverse**.

10.5.15 This finding is most relevant to the two smaller hotels closest to the site, as it is primarily informed by the likely construction dust and air quality effects. It is considered likely that effects on the two larger hotels, those further from the proposed construction site, would be likely to be negligible.

Sensitivity test for programme delay

10.5.16 For the assessment of socio-economic 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 24 Appendix N), there would be no new receptors, within the assessment area, requiring assessment as a result of a one year delay.

10.6 Operational effects assessment

10.6.1 Operational effects for socio-economics for this site have not been assessed (see para. 10.1.2).

10.7 Cumulative effects assessment

10.7.1 As described in Section 10.3, one, Creekside Village East, would be under construction during the peak construction year at this site.

10.7.2 In respect of the non-amenity related effect assessment undertaken in Section 10.5, as this development is not located on or within the proposed project site, it would not be possible for it to give rise to cumulative effects in respect of the displacement of the builders' merchant business.

10.7.3 In respect of the amenity effect assessments undertaken in Section 10.5, the development is located within the assessment area for amenity effects and so it could give rise to cumulative effects on the amenity of potentially sensitive receptors such as residents and the hotels.

10.7.4 The air quality and construction dust, and noise and vibration cumulative effect assessments (see Section 4 and Section 9 respectively) have not identified any additional significant cumulative effects on the receptors considered in the amenity effect assessments in Section 10.5. The visual effect cumulative assessment concluded that visual effects on residential receptors represented by viewpoints 1.1 and 1.4 would be elevated but would remain not significant.

10.7.5 Having regard to those results, although there may be elevated amenity effects, it is considered that effects on the residential receptors and the hotels would remain not significant. Therefore the effects on socio-economics would remain as described in Section 10.5 above.

10.7.6 In the event that the programme for the Thames Tideway Tunnel project is delayed by approximately a year, the Creekside Village East development would be assumed to be complete and operational in the assessment year for socio-economics. Therefore there would be no cumulative effects.

10.8 Mitigation

10.8.1 The above assessment has concluded that there would be no major or moderate adverse socio-economic effects at the site requiring additional mitigation.

10.9 Residual effects assessment

10.9.1 As no mitigation is proposed, the residual effects would remain as described in Section 10.5.

10.9.2 All residual effects are presented in Section 10.10.

10.10 Assessment summary

Vol 24 Table 10.10.1 Socio-economics – summary of construction assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Business – builders' merchant	Displacement of business – builders' merchant	Minor adverse	None	Minor adverse
Residents	Effect on the amenity of residents	Minor adverse	None	Minor adverse
Businesses – hotels	Effect on hotel businesses due to construction activity	Minor adverse	None	Minor adverse

References

[1] Department of Environment, Food and Rural Affairs. National Policy Statement for Waste Water (2012). Available from: http://www.defra.gov.uk/publications/files/pb13709-waste-water-nps.pdf. Accessed November 2012

[2] Valuation Office Agency. *Commercial and Industrial Property Vacancy Statistics* (2005). Available at http://www.neighbourhood.statistics.gov.uk/. Accessed 5th March 2012

[3] Glenny. *Glenny Databook: Essential Market Data Quarter 3 2011* (2011). Available at: http://www.glenny.co.uk/default.aspx?mId=52. Accessed 5th March 2012

[4] Glenny. *Glenny Databook: Quarter 1 2007* (2007). Available at: http://www.glenny.co.uk/default.aspx?mId=52. Accessed 5th March 2012

[5] Homes and Communities Agency. *Employment Densities Guide*, 2nd Edition (2010).

[6] 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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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.24**

Volume 24: Greenwich Pumping Station site assessment

Section 11: Townscape and visual

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Environmental Statement

Volume 24: Greenwich Pumping Station 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 the Greenwich Pumping Station 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 are assessed. The assessment includes construction phase effects on townscape character areas, and visual effects during daytime and also night time to take account of effects arising from additional lighting. The assessment also identifies mitigation measures where appropriate.

11.1.3 Operational effects have not been assessed on the basis that the limited changes in operation (comprising machinery within the existing pumping station building, minor improvements to the facade of the East Beam Engine House, limited areas of new planting and wildflower meadow, a shaft elevated above existing ground levels by approximately 1m and no operational lighting) would have no significant effects.

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 24 Greenwich Pumping Station Figures).

11.1.7 A separate but related assessment of effects on the setting of heritage assets is included in Section 7 of this volume.

11.2 Proposed development relevant to townscape and visual

11.2.1 The proposed development is described in Section 3 of this volume. The elements of the proposed development relevant to the townscape and visual assessment are set out below.

Construction

11.2.2 The specific construction works which may give rise to effects on townscape character and visual receptors are listed as follows, with the activities likely to give rise to the most substantial townscape and visual effects described first:

a. use of cranes during shaft sinking

b. installation of a noise shed during the Greenwich connection tunnel drive and secondary lining of the tunnel

c. clearance of existing structures and vegetation, including two mature trees along Norman Road

d. installation of 3.6m high hoardings around the boundary of the construction site

e. provision of welfare and office facilities, assumed to be a maximum of three storeys in height

f. vehicular construction access to the site off Norman Road and Greenwich High Road

g. lighting of the site when required (continuously during the Greenwich connection tunnel drive and secondary lining, lasting approximately 27 months, and extended working hours, as defined in Section 3 of this volume, during some other activities, such as the diaphragm wall works).

Code of Construction Practice

11.2.3 Measures incorporated into the *Code of Construction Practice (CoCP)*[i] *Part A* to reduce townscape and visual impacts include:

a. protection of existing trees to *BS5837 Trees in Relation to Construction – Recommendations* (Section 11)

b. protection of listed structures (Section 12)

c. installation of well-designed visually attractive hoardings (Section 4)

d. the use of appropriate capped and directional lighting when required (Section 4).

11.2.4 Measures incorporated into the *CoCP Part B* include:

a. provision for incorporating suitable art work on public facing sections of hoarding (Section 4)

b. use of 3.6m high hoardings (Section 4)

c. protective measures to prevent strike damage to the Grade II listed Beam Engine Houses and Central Boiler House, the Grade II listed Coal sheds, and the Grade II listed Network Rail viaduct (Section 12).

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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*).

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 Royal Borough (RB) of Greenwich, London Borough (LB) of Lewisham (located on the opposite side of Deptford Creek) and English Heritage have been consulted on the detailed approach to the townscape and visual assessment, including the number and location of viewpoints. English Heritage (May 2011) has confirmed acceptance of the proposed viewpoints. The RB of Greenwich and LB of Lewisham have not commented on the proposed viewpoints.

11.3.3 The stakeholders were also consulted on proposed changes to the scope of the assessment to remove the operational phase assessment due to the negligible effects arising from the operational structures. The stakeholders have not commented on the proposed changes.

11.3.4 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

11.3.5 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 (September 2010)

b. Photographic survey of townscape character areas (September 2011)

c. Winter photographic survey of the view from each visual assessment viewpoint (December 2011).

11.3.6 No photomontages have been produced for this site, on the basis that the effects during construction could be adequately assessed without them. Therefore, no verifiable photography or surveying has been undertaken for this site.

11.3.7 With specific reference to the Greenwich Pumping Station site, baseline information on open space distribution and type, conservation areas and townscape character has been gathered through a review of:

a. The *Unitary Development Plan* saved policies for the RB of Greenwich (RB of Greenwich, 2006)[2]

b. The *Core Strategy for the LB of Lewisham* (LB of Lewisham, 2011)[3]

c. *Ashburnham Triangle Conservation Area Character Appraisal and Management Strategy*, produced by the RB of Greenwich (RB of Greenwich, 2008)[4]

d. *West Greenwich Conservation Area Character Appraisal*, produced by the RB of Greenwich (RB of Greenwich, no date)[5]

e. Deptford Creekside Conservation Area Appraisal, produced (LB Lewisham, 2012)[6].

Construction

11.3.8 The assessment methodology for the construction phase follows that described in Vol 2. Site specific variations are described below.

11.3.9 With reference to the Greenwich Pumping Station site, the peak construction phase relevant to this topic would be from Site Year 2 to Site Year 4 of construction, during the Greenwich connection tunnel drive and subsequent secondary lining, including 24 hour working, the presence of cranes at the site, and export and import of material by road. Site Year 2 has been used as the assessment year for townscape and visual effects.

11.3.10 The assessment area, defined using the methodology provided in Vol 2, is indicated in Vol 24 Figure 11.4.4 for townscape and Vol 24 Figure 11.4.5 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 to the north along Norman Road and to the west along the railway where the ZTV is extensive but the construction works would be barely perceptible. The scale of the visual assessment area has been set by the maximum extent of the construction phase ZTV, except in those locations to the north along Norman Road and to the west along the railway where the construction works would be barely perceptible. All visual assessment viewpoints are located within the ZTV.

11.3.11 Section 11.5 describes the likely significant effects arising from the construction at the Greenwich Pumping Station site. The nearest Thames Tideway Tunnel project site to Greenwich Pumping Station is Deptford Church Street site, however the assessment areas do not coincide, and therefore no other Thames Tideway Tunnel project sites are included in this assessment.

11.3.12 For the construction base case for the assessment of effects arising from the proposed development at the Greenwich Pumping Station site, it is assumed that the following developments within the assessment area would be complete and occupied by Site Year 2 of construction:

a. change of use from office to hotel for a mixed use development at 43-81 Greenwich High Road, adjacent to the site

b. 83-87 Greenwich High Road mixed use scheme including commercial uses at ground floor with residential above, adjacent to the site

c. Greenwich Industrial Estate mixed use development including retail, commercial and residential, adjacent to the site

d. Hilton's Wharf residential and commercial development on Norman Road close to the site

e. Seager Buildings mixed use development incorporating a 26 storey residential tower, 250m southwest of the site.

11.3.13 For the purposes of the cumulative effects assessment, it is assumed that the Creekside Village East (Thanet Wharf) mixed use development, identified within the site development schedule (Vol 24 Appendix N), would be under construction during Site Year 2 of construction at the Greenwich Pumping Station site.

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

Assumptions and limitations

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

Assumptions

11.3.16 For the purposes of the construction phase assessment, it is assumed that the construction activities and plant, site hoardings, welfare facilities and access points are in the location shown on the Construction phases - phase 2 (tunnelling) plan (see separate volume of figures – Section 1). The assessment of effects would be no worse if these elements of the proposed development were in different locations within the maximum extent of working area (shown on Construction phases plans in 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).

Limitations

11.3.17 The assumed completion of a number of developments in the construction phase base case would introduce additional visual receptors. Effects on these receptors are assessed with reference to viewpoints 1.5 and 1.6 (para. 11.5.33 to para. 11.5.35). Due to suitable representative publicly accessible locations for viewpoints not being available, no photo has been included from these locations and the assessment has been undertaken based on professional judgement.

11.3.18 Despite the limitations identified above, the assessment is considered robust.

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 both daytime and night time. 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.

Topography

11.4.3 The assessment area is broadly characterised by relatively flat ground adjacent to Deptford Creek, with no notable topographic features. The land rises gently towards the east.

Land use

11.4.4 The assessment area is located along Deptford Creek and is dominated by industrial uses, although a new residential development is under construction to the south of the site and further regeneration is anticipated (see para. 11.4.70 which describes how the baseline would change following the assumed completion of a number of developments). The townscape to the southeast, further away from Deptford Creek, is dominated by residential uses.

Development patterns and scale

11.4.5 Vol 24 Figure 11.4.1 (see separate volume of figures) illustrates the pattern and scale of development including building heights within the assessment area.

11.4.6 The industrial areas surrounding the site are characterised by two to three storey warehouses, ranging from small units to large scale sheds. The development pattern is typical of such developments, with small access roads arranged around Deptford Creek and the Docklands Light Railway (DLR).

11.4.7 The area to the southeast of the site is dominated by two to three storey residential terraces arranged in a grid pattern, bounded to the north by Greenwich High Road.

Vegetation patterns and extents

11.4.8 The pattern and extent of vegetation within the assessment area, including tree cover, is shown in the aerial photograph included in Vol 24 Figure 11.4.2 (see separate volume of figures).

11.4.9 The townscape surrounding the site is industrial in nature, with a notable absence of vegetation, apart from around the boundaries of the Greenwich Pumping Station site itself. The residential area to the southeast of the site is characterised by dense tree cover, although this is largely due to the abundance and size of private gardens rather than substantial public open spaces or street trees.

11.4.10 A number of trees to the southeast of the site are protected by Tree Preservation Orders (TPOs), and trees within conservation areas are also indirectly protected.

Open space distribution and type

11.4.11 The assessment area has a notable absence of either public or private open spaces. Within the industrial area either side of Deptford Creek, open space is limited to areas of hardstanding used for car parking or storage. Within the residential area to the southeast of the site, open spaces are largely limited to small private gardens.

Transport routes

11.4.12 Vol 24 Figure 11.4.3 (see separate volume of figures) illustrates the transport network within the assessment area, including cycleways, footpaths and Public Rights of Way.

11.4.13 The site is located immediately adjacent to a DLR viaduct, to the south of the mainline railway between Deptford and Greenwich, and to the north of Greenwich High Road, which is characterised by high levels of traffic.

11.4.14 A cycle route and public footpath runs along the northern boundary of the site.

Site character assessment

11.4.15 The site is located on land within and surrounding the existing Greenwich Pumping Station complex, including:

a. the East Beam Engine Houses and cleared land surrounding it

b. an area of land in the southwest of the pumping station complex currently occupied by disused Grade II listed coal sheds

c. land within the Greenwich Pumping Station compound to the north of the Beam Engine House

d. land to the north of the elevated railway lines, beyond the Greenwich Pumping Station compound.

11.4.16 The character of the site, including cleared ground adjacent to the pumping station and one of the Beam Engine Houses, is illustrated by Vol 24 Plate 11.4.1 and the components of the site are described in more detail in Vol 24 Table 11.4.1.

Vol 24 Plate 11.4.1 The character of the site

Date taken: 1 September 2011. 18mm lens.

Vol 24 Table 11.4.1 Townscape – site components

ID	Component	Description	Condition
01	Public footpath and cycleway	Tarmac path linking Norman Road and Creekside	Fair condition
02	Mature trees along Norman Road	Eight mature trees located along the eastern boundary of the site.	Good condition
03	Boundary wall	1.5m high brick wall along the eastern boundary of the site.	Fair condition
04	Boundary metal palisade fencing	2m high galvanised palisade fencing	Fair condition
05	Grade II listed coal sheds	Single storey coal sheds comprising an iron frame and slate roof.	Good condition
06	Grade II listed Beam Engine Houses	Two storey engine houses with a one storey boiler house linking the two. The buildings are constructed of grey brick with slate roofs and cast iron railings leading to the doors.	Fair condition

ID	Component	Description	Condition
07	Trees and shrubs to the north of the Beam Engine Houses	Area of unmanaged scattered semi-mature trees and shrubs.	Poor condition
08	Trees to the south of the Beam Engine Houses	Semi-mature and mature trees within areas of mown grass.	Good condition
09	Cooling towers	Three cooling towers (2m high) surrounded by 2m high steel palisade fencing.	Fair condition
10	Grade II listed railway viaduct	Brick built railway viaduct with arches infilled for storage purposes.	Fair condition
11	Industrial buildings north of the railway	Brick clad light industrial buildings.	Poor condition

11.4.17 A baseline description of the Grade II listed Greenwich Pumping Station buildings and the Grade II listed London and Greenwich Railway as heritage assets are provided in Section 7.4 of this volume.

11.4.18 The condition of the townscape within the site is fair, with certain features, including the Beam Engine Houses, in need of repair and refurbishment.

11.4.19 The industrial use of the site, set amongst the wider industrial area and close to the DLR, mainline railway and Greenwich High Road, means the site has a low level of tranquillity.

11.4.20 The site has limited townscape value due to the lack of open space and the industrial use of the area. However, the Grade II listed Beam Engine Houses and coal sheds (also Grade II listed) represent components of the character area that are valued at the borough scale by virtue of their historical importance.

11.4.21 Due to the fair condition, limited townscape value and low level of tranquillity, the site has a low sensitivity to change.

Townscape character assessment

11.4.22 There are two townscape character areas surrounding the site, Creekside Industrial townscape character area (TCA) surrounding the site and Ashburnham Triangle Conservation Area TCA to the southeast (identified in Vol 24 Figure 11.4.4 in separate volume of figures). Each area is described below.

Creekside Industrial TCA

11.4.23 This character area is dominated by industrial uses focused around Deptford Creek, the DLR and the mainline railway between Deptford and Greenwich Stations. The area is characterised by a mix of one to three storey small scale units within industrial estates and large scale, low height warehouses. The area is bisected north-south by Deptford Creek, which is crossed by the DLR and railway line and a footpath, which in turn bisect the area east-west. The areas to the north and south of the site are currently undergoing regeneration, with a number of residential and mixed use projects under construction (listed in para. 11.3.12), similar in character to new development to the northeast of the site. The setting of the area is dominated by residential properties, including large scale developments to the north and south. The Beam Engine Houses form an important part of the setting of this character area. Part of the area, to the west of Deptford Creek, is located within Deptford Creekside Conservation Area. The character of this area is illustrated by Vol 24 Plate 11.4.2. A baseline description of Deptford Creekside Conservation Area as a heritage asset is provided in Section 7.4 of this volume.

Vol 24 Plate 11.4.2 Creekside Industrial TCA

Date taken: 1 September 2011. 18mm lens.

11.4.24 The buildings and public realm within the area are poorly maintained. The overall townscape condition is poor.

11.4.25 Tranquillity within the area is limited by high levels of heavy good vehicle (HGV) traffic, the presence of the busy railway line, a lack of street trees and open spaces, and the presence of the industrial land uses.

11.4.26 The area has limited townscape value by virtue of the poor condition of the public realm and the commercial land use.

11.4.27 Due to the poor condition and limited value of the area, this character area has a low sensitivity to change.

Ashburnham Triangle Conservation Area TCA

11.4.28 This character area is defined by the Ashburnham Triangle Conservation Area boundary, designated by the RB of Greenwich. The area is characterised by 18th and 19th century two to three storey residential terraces, in a distinct area defined by Blackheath Road, Greenwich High Road and Greenwich South Street. The architecture is consistent in design which provides a uniform appearance to the area. Residential properties have small front gardens and large rear gardens, characterised by widespread mature trees. The development pattern is organised on a regular grid pattern. The area has a notable absence of public open spaces. The area is enclosed in character, with the wider setting dominated by further residential areas to the south and industrial units to the north. The character of this area is illustrated by Vol 24 Plate 11.4.3.

Vol 24 Plate 11.4.3 Ashburnham Triangle Conservation Area TCA

Date taken: 1 September 2011. 18mm lens.

11.4.29 A baseline description of Ashburnham Triangle Conservation Area as a heritage asset is provided in Section 7.4 of this volume.

11.4.30 The buildings and public realm within the area are well maintained. The overall townscape condition is good.

11.4.31 Despite the presence of Greenwich High Road along the northern boundary of this area, and the wider presence of industrial uses and railway lines, the townscape has moderate levels of tranquillity due to the residential character and enclosed nature of the area.

11.4.32 The townscape of the character area is valued at the borough level, by virtue of the conservation area designation.

11.4.33 Due to the good condition and borough value attributed to the townscape, this character area has a high sensitivity to change.

Visual baseline

11.4.34 Vol 24 Figure 11.4.5 (see separate volume of figures) indicates the location of viewpoints referenced below. All London View Management Framework London Panoramas, residential and recreational receptors have a high sensitivity to change, transport receptors have a medium sensitivity to change and employment receptors have a low sensitivity to change.

London View Management Framework London Panoramas

London Panorama 6A.1 – Blackheath Point to St Paul's Cathedral

11.4.35 This London Panorama from Blackheath Point to St Paul's Cathedral, designated in the LVMF passes through the centre of the site and has a high sensitivity to change.

Vol 24 Plate 11.4.4 London Panorama 6A.1: Winter view

Winter – date taken: 20 December 2011. 50mm lens.

11.4.36 The view (illustrated in Vol 24 Plate 11.4.4) towards St Paul's Cathedral is largely unobstructed, but framed by other tall buildings in the middle ground; the most visually apparent feature is St Paul's Church in Deptford (Grade I listed). The site is partially visible in the middle ground of the view, set in front of the elevated DLR and railway.

11.4.37 At night, the foreground of the view is dimly lit by street lighting along residential streets and light spill from residential properties. The background of the view is lit by commercial buildings in Central London.

The site, in the middle ground of the view, sits within a dimly lit industrial area along Deptford Creek.

Residential

11.4.38 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 southwest from residences on Norman Road

11.4.39 This viewpoint is representative of the typical oblique view from residential properties on Norman Road, close to the junction with Thornham Street.

Vol 24 Plate 11.4.5 Viewpoint 1.1: Winter view

Winter – date taken: 20 December 2011. 35mm lens.

11.4.40 The view (illustrated in Vol 24 Plate 11.4.5) is linear in nature along Norman Road, and is framed by residential development to the east and industrial units along Deptford Creek to the west. The view from upper storeys encompasses open panoramas over the creek and surrounding industrial uses. The view towards the site is largely obscured by intervening buildings and the elevated railway line on the northern boundary of the site in the background of the view.

11.4.41 At night, the view is lit by street lighting and light spill from surrounding residential properties. The industrial character in the background of the view is dimly lit.

Viewpoint 1.2: View west from residences on Greenwich High Road close to the junction with Egerton Drive

11.4.42 This viewpoint is representative of the typical view from residential properties located on the corner of Greenwich High Road and Egerton Drive.

Vol 24 Plate 11.4.6 Viewpoint 1.2: Winter view

Winter – date taken: 20 December 2011. 18mm lens.

11.4.43 The foreground of the view (illustrated in Vol 24 Plate 11.4.6) is characterised by commercial and retail units along Greenwich High Road and residential properties at the southern end of Norman Road, which partially obscure views towards the site. The existing Beam Engine Houses are visible in the background of the view, partially obscured by mature trees within the Greenwich Pumping Station compound.

11.4.44 At night, the foreground of the view is brightly lit by street lighting and light spill from surrounding buildings. The site, in the background of the view, is dimly lit.

Viewpoint 1.3: View northeast from residences on Greenwich High Road close to the junction with Burgos Grove

11.4.45 This viewpoint is representative of the typical oblique view from residential properties located on Greenwich High Road, close to the junction with Burgos Grove.

Vol 24 Plate 11.4.7 Viewpoint 1.3: Winter view

Winter – date taken: 20 December 2011. 18mm lens.

11.4.46 The view (illustrated in Vol 24 Plate 11.4.7) is linear in nature along Greenwich High Road, and is characterised by residential blocks. Views of the site are almost totally obscured by a newly built residential development to the south of the site.

11.4.47 At night, the view is lit by street lighting and light spill from surrounding residential properties.

Viewpoint 1.4: View southeast from residences on Berthon Street

11.4.48 This viewpoint is representative of the typical view from residential properties along Berthon Street, adjacent to the Sue Godfrey Nature Reserve.

Vol 24 Plate 11.4.8 Viewpoint 1.4: Winter view

Winter – date taken: 20 December 2011. 18mm lens.

11.4.49 The foreground of the view (illustrated in Vol 24 Plate 11.4.8) is dominated by the boundary walling and tree planting within the nature reserve. Wider views encompass industrial units alongside Deptford Creek, which largely obscure views towards the site.

11.4.50 At night, the immediate foreground of the view is dimly lit by street lighting, but the open space and industrial area beyond are largely unlit.

Viewpoint 1.5: View north from newly built residences in the 43-81 Greenwich High Road development (base case scheme)

11.4.51 This viewpoint is representative of the typical view for residents of a new residential and hotel block which is anticipated will have changed use from offices in advance of the proposed construction at Greenwich Pumping Station site. The view at present is dominated by clear views across the majority of the site, including the Grade II listed coal sheds in the foreground of the view. Due to the viewpoint not being publicly accessible at present, no photo has been included from this location.

11.4.52 At night, the view is dimly lit by light spill from surrounding commercial and industrial premises.

Viewpoint 1.6: View west from residences in the Greenwich Industrial Estate development (base case scheme)

11.4.53 This viewpoint is representative of the typical view for residents of a new residential block which is anticipated will be completed in advance of the proposed construction at Greenwich Pumping Station site. The view at present is dominated by industrial units in the foreground, largely obscuring views towards the site. Due to the viewpoint not being publicly accessible at present, no photo has been included from this location.

11.4.54 At night, the view is dimly lit by light spill from surrounding commercial and industrial premises.

Recreational

11.4.55 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 southeast from the footbridge over Deptford Creek

11.4.56 This viewpoint is representative of the typical view for pedestrians crossing the footbridge over Deptford Creek, immediately adjacent to the northern edge of the site, and running to the south of the mainline railway.

Vol 24 Plate 11.4.9 Viewpoint 2.1: Winter view

Winter – date taken: 20 December 2011. 18mm lens.

11.4.57 The view (illustrated in Vol 24 Plate 11.4.9) is linear in nature along Deptford Creek and is framed by industrial premises to the west and the site to the east. Views of site are partially obscured by the DLR viaduct passing over Deptford Creek in the foreground of the view, although the Beam Engine House is visible underneath the viaduct.

11.4.58 At night, the view is dimly lit by light spill from residential properties along the western edge of Deptford Creek. However, the majority of the view is largely unlit.

Transport

11.4.59 Travel through an area is often the means by which the greatest numbers of people view the townscape. Such receptors generally have a medium sensitivity to change.

Viewpoint 3.1: View south from Norman Road, north of the railway

11.4.60 This viewpoint is representative of the typical view for people travelling south towards the site along Norman Road.

Vol 24 Plate 11.4.10 Viewpoint 3.1: Winter view

Winter – date taken: 20 December 2011. 35mm lens.

11.4.61 The view (illustrated in Vol 24 Plate 11.4.10) is linear in nature along Norman Road and is contained on both sides by industrial units. The view towards the site is framed by the DLR and mainline railway bridges which cross over the road just south of the viewpoint. The mature trees along the eastern boundary of the site are visible through the railway bridge. Views of the remainder of the site are obscured.

11.4.62 At night, the view is dimly lit by light spill from surrounding commercial premises.

Viewpoint 3.2: View west from Greenwich Station

11.4.63 This viewpoint is representative of the typical oblique view for people using Greenwich Station.

Vol 24 Plate 11.4.11 Viewpoint 3.2: Winter view

Winter – date taken: 20 December 2011. 35mm lens.

11.4.64 The view (illustrated in Vol 24 Plate 11.4.11) is linear in nature along the railway line. Views towards the site are largely obscured by intervening buildings in the background of the view.

11.4.65 At night, the foreground of the view is lit by lighting along the station platform. The background of the view, along the railway line, is largely unlit although there is intermittent light spill from passing trains.

Employment

11.4.66 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 west from industrial premises along Deptford Creek

11.4.67 This view is representative of the view from industrial premises on the west bank of Deptford Creek, opposite the site.

Vol 24 Plate 11.4.12 Viewpoint 4.1: Winter view

Winter – date taken: 20 December 2011. 18mm lens.

11.4.68 The foreground of the view (illustrated in Vol 24 Plate 11.4.12) is dominated by the elevated DLR viaduct which crosses Deptford Creek in this location. The viaduct largely obscures views towards the site, although the existing Beam Engine House is visible underneath the structure of the bridge.

11.4.69 At night, the foreground and background of the view is largely unlit.

Construction base case

11.4.70 The base case in Site Year 2 of construction taking into account the schemes described in para. 11.3.12 would change the following receptors:

a. Creekside Industrial TCA – By Site Year 2 of construction, the character of this area would be likely to have changed substantially. The assumed redevelopment of a number of commercial, industrial and disused areas into the residential and mixed use developments listed in para. 11.3.12 would change the sensitivity of the character area from low to be medium by Site Year 2 of construction.

b. Viewpoint 1.3 – By Site Year 2 of construction, views towards the site would be obscured by the completed residential development (83-87 Greenwich High Road) to the south of the site.

11.4.71 In addition, the assumed completion of the 83-87 Greenwich High Road scheme and the assumed change of use from office to hotel at 43-81 Greenwich High Road would introduce additional residential visual receptors, represented by viewpoints 1.5 and 1.6.

11.4.72 All other receptors would remain as detailed in the baseline.

11.5 Construction effects assessment

11.5.1 The following section details the likely significant effects arising from construction at Greenwich Pumping Station site.

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 (Defra, 2012)[7] recognises that nationally significant infrastructure projects are likely to take place in mature urban environments, with adverse construction effects on townscape and visual receptors likely to arise. In addition, construction works are a commonplace feature across London, and therefore the following assessment should be viewed in this context. It should also be noted that construction effects are temporary in nature and relate to the peak construction year defined in Section 11.3. Effects during other phases of works are likely to be less due to fewer construction 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 phases plans, see separate volume of figures – Section 1).

Site character assessment

11.5.4 Effects on the character of the site would arise from clearance of structures, trees and vegetation, activity, plant and lighting associated with construction of the shaft and ventilation equipment, and secondary lining of the tunnel, and the presence of the noise shed, hoardings and welfare facilities. The impacts on specific components of the site are described in Vol 24 Table 11.5.1 below.

Vol 24 Table 11.5.1 Townscape – impacts on existing site components during construction

ID	Component	Impacts
01	Public footpath and cycleway	This would be temporarily diverted to the north during construction.
02	Mature trees along Norman Road	The northernmost trees would be removed to allow construction access to the site
03	Boundary wall	Parts of this wall would be demolished to allow construction access to the site.
04	Boundary metal palisade fencing	This would be removed during construction.
05	Grade II listed coal sheds	These would be retained and protected throughout the works
06	Grade II listed Beam Engine Houses	These would be protected and retained during the works. Works would be undertaken within the most northerly Beam Engine House to install ventilation equipment.

ID	Component	Impacts
07	Trees and shrubs to the north of the Beam Engine Houses	To be removed as necessary during construction.
08	Trees to the south of the Beam Engine Houses	Retained and protected during construction.
09	Cooling towers	These would be retained throughout construction.
10	Grade II listed railway viaduct	Unaffected and protected during construction.
11	Industrial buildings north of the railway	Demolished during construction.

11.5.5 The site's low level of tranquillity would be altered to a limited extent by the introduction of construction vehicles, plant equipment and high levels of activity in an area not currently intensively used.

11.5.6 Due to the high level of change to character and limited change to tranquillity, the overall magnitude of change to the site during construction is considered to be high.

11.5.7 The high magnitude of change, assessed alongside the low sensitivity of the site, would result in **minor adverse** effects.

11.5.8 The assessment of specific effects on the setting of the Grade II listed Greenwich Pumping Station buildings and the Grade II listed London and Greenwich Railway viaduct as heritage assets are set out in Section 7 of this volume.

Townscape character areas assessment

Creekside Industrial TCA

11.5.9 This character area surrounds the proposed site. The immediate setting of the area would be affected by the presence of construction activity and plant, welfare facilities, site hoardings and the noise shed around the CSO site. However, key elements of the setting, including the Grade II listed Beam Engine Houses and coal sheds, would be largely unaltered. The wider setting would be largely unaffected by the proposed development as construction activity would be barely perceptible.

11.5.10 The area's low level of tranquillity would be affected to a limited extent by the intensity of construction activities, including road transport.

11.5.11 Due to the change in immediate setting and limited changes to tranquillity, the magnitude of change is considered to be low.

11.5.12 The low magnitude of change, assessed alongside the medium sensitivity of this character area, would result in **minor adverse** effects.

11.5.13 The assessment of specific effects on the setting of Deptford Creekside Conservation Area as a heritage asset is set out in Section 7 of this volume.

Ashburnham Triangle Conservation Area TCA

11.5.14 The proposed site forms part of the northern setting for this character area. The setting would be affected by increased HGV traffic along Greenwich High Road and Norman Road, site hoardings and the presence of tall construction plant and the noise shed around the shaft in the centre of the site. However, aside from tall construction plant, construction activity around the shaft would be largely obscured by the existing Beam Engine Houses, and the majority of the area's setting would therefore be unaffected.

11.5.15 The area's moderate level of tranquillity would be affected to a limited extent by an increase in HGV movements along Greenwich High Road, and construction activity, particularly in the location of the coal sheds.

11.5.16 Due to changes in the wider setting and limited changes to tranquillity, the magnitude of change is considered to be low.

11.5.17 The low magnitude of change, assessed alongside the high sensitivity of this character area, would result in **minor adverse** effects.

11.5.18 The assessment of specific effects on the setting of Ashburnham Triangle Conservation Area as a heritage asset is set out in Section 7 of this volume.

Townscape – sensitivity test for programme delay

11.5.19 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 11.5.18). The assessment area is subject to ongoing and long term change and a delay to the Thames Tideway Tunnel project is not likely to change the sensitivity to change of the townscape character areas already presented (paras. 11.4.2 to 11.4.33).

Visual assessment

11.5.20 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 Panorama 6A.1 – Blackheath Point to St Paul's Cathedral

11.5.21 During construction, the noise shed and tall construction plant at the site would be visible in the middle ground of the view during the daytime, set partially in front of St Paul's Church, Deptford (Grade I listed), but would not obstruct views towards St Paul's Cathedral. Other construction activity at the site would be partially obscured by the intervening low-rise buildings. The majority of the view would be unaffected and construction activity at the site would not lead to new features visible on the skyline.

Therefore, the magnitude of change on this London Panorama is considered to be low.

11.5.22 The low magnitude of change, assessed alongside the high sensitivity of the receptor, would result in **minor adverse** effects during the daytime.

11.5.23 At night, lighting at the site would be barely perceptible due to intervening buildings and structures and the use of capped and directional lighting (described in para. 11.2.3). Therefore, the magnitude of change on this London Panorama at night is considered to be negligible, resulting in a **negligible** effect.

Residential

Viewpoint 1.1: View southwest from residences on Norman Road; and Viewpoint 1.4: View southeast from residences on Berthon Street

11.5.24 Views from these locations would be affected to a limited extent by the background visibility of the noise shed and cranes at the site during the daytime. The majority of construction activities would be screened by intervening buildings and the elevated railway line to the north of the site. The cranes would form barely perceptible components in the background of the views, set against ongoing construction activity at the residential development to the north of the site. Therefore, the magnitude of change is considered to be negligible.

11.5.25 The negligible magnitude of change, assessed alongside the high sensitivity of these receptors, would result in a **negligible** effect during the daytime.

11.5.26 At night, lighting at the site would be barely perceptible due to intervening buildings and structures and the use of capped and directional lighting (described in para. 11.2.3). Therefore, the magnitude of change on these receptors at night is considered to be negligible, resulting in a **negligible** effect.

Viewpoint 1.2: View west from residences on Greenwich High Road close to the junction with Egerton Drive

11.5.27 The foreground of the view from this location would be affected by site hoardings, stacked welfare facilities along the southern boundary of the site and road transport entering the site. However, views of the main construction activity around the shaft would be largely obscured by the existing Beam Engine Houses. Therefore, the magnitude of change is considered to be medium.

11.5.28 The medium magnitude of change, assessed alongside the high sensitivity of the receptor, would result in **moderate adverse** effects during the daytime.

11.5.29 At night, lighting at the site would be visible in the background of the view beyond the brightly lit foreground. However, because of the use of capped and directional lighting (described in para. 11.2.3) the magnitude of change to the receptor at night is considered to be negligible, resulting in a **negligible** effect.

Viewpoint 1.3: View northeast from residences on Greenwich High Road close to the junction with Burgos Grove

11.5.30 Views from this location would be affected to a limited extent during construction by increased levels of HGV traffic along Greenwich High Road. However, views of the main construction activity around the shaft would be obscured by the completed residential development to the south of the site. Therefore, the magnitude of change is considered to be negligible.

11.5.31 The negligible magnitude of change, assessed alongside the high sensitivity of the receptor, would result in a **negligible** effect during the daytime.

11.5.32 At night, lighting at the site would be barely perceptible due to intervening buildings and structures and the use of capped and directional lighting (described in para. 11.2.3). Therefore, the magnitude of change on this receptor at night is considered to be negligible, resulting in a **negligible** effect.

Viewpoint 1.5: View north from newly built residences in the 43-81 Greenwich High Road development; and Viewpoint 1.6: View west from newly built residences in the Greenwich Industrial Estate development; and (base case schemes)

11.5.33 Views from ground level would encompass site hoardings, construction plant, construction traffic and storage in the foreground, set amongst an existing industrial context. The noise shed and tall construction plant around the CSO site would be visible in the background of the view, partially obscured by intervening buildings and structures including the retained coal sheds. Construction activity, including around the shaft, would be more visible from upper storeys. Therefore, the magnitude of change is considered to be medium.

11.5.34 The medium magnitude of change, assessed alongside the high sensitivity of the receptors, would result in **moderate adverse** effects during the daytime.

11.5.35 At night, lighting at the site would be visible, particularly from upper storeys, although partially obscured by intervening buildings and structures including the retained coal sheds. Due to the use of capped and directional lighting (described in para. 11.2.3) the magnitude of change to the receptor at night is considered to be low, resulting in **minor adverse** effects.

Recreational

Viewpoint 2.1: View southwest from the footbridge over Deptford Creek

11.5.36 Construction activity within the site would be visible beyond the hoardings at the site boundary. The construction plant, construction vehicles, the noise shed and cranes would be visible beyond the DLR viaduct in the foreground of the view, although partially obstructed by the structure of the viaduct. Therefore, the magnitude of change is considered to be medium.

11.5.37 The medium magnitude of change, assessed alongside the high sensitivity of the receptor, would result in **moderate adverse** effects during the daytime.

11.5.38 At night, lighting at the site would be visible in the foreground of the view, beyond the site hoardings. However, because of the use of capped and directional lighting (described in para. 11.2.3) the magnitude of change to the receptor at night is considered to be low, resulting in **minor adverse** effects.

Transport

Viewpoint 3.1: View south from Norman Road, north of the railway

11.5.39 Views from this location would be affected to a limited extent during construction. The view down Norman Road would be affected by an increase in HGV traffic and the removal of mature trees at the northeast corner of the site. Wider views of construction activity would be largely obscured by the elevated railway line and intervening buildings, although the cranes would be visible above the viaduct. Overall, the magnitude of change is considered to be low.

11.5.40 The low magnitude of change, assessed alongside the medium sensitivity of the receptor, would result in **minor adverse** effects during the daytime.

11.5.41 At night, lighting at the site would be barely perceptible due to intervening buildings and structures and the use of capped and directional lighting (described in para. 11.2.3). Therefore, the magnitude of change on this receptor at night is considered to be negligible, resulting in a **negligible** effect.

Viewpoint 3.2: View west from Greenwich Station

11.5.42 Views from this location would not be affected during construction as no construction activities or plant would be visible. Therefore, the magnitude of change is considered to be negligible.

11.5.43 The negligible magnitude of change, assessed alongside the medium sensitivity of the receptor, would result in a **negligible** effect during the daytime.

11.5.44 At night, lighting at the site would be barely perceptible due to intervening buildings and structures and the use of capped and directional lighting (described in para. 11.2.3). Therefore, the magnitude of change on this receptor at night is considered to be negligible, resulting in a **negligible** effect.

Employment

Viewpoint 4.1: View west from industrial premises along Deptford Creek

11.5.45 Construction activity within the site would be clearly visible beyond the hoardings at the site boundary. The construction plant, construction vehicles, noise shed and cranes would be visible through the DLR viaduct in the foreground of the view. Therefore, the magnitude of change is considered to be high.

11.5.46 The high magnitude of change assessed alongside the low sensitivity of the receptor, would result in **minor adverse** effects during the daytime.

11.5.47 At night, lighting at the site would be visible in the foreground of the view, beyond the site hoardings. However, because of the use of capped and directional lighting (described in para. 11.2.3) the magnitude of change to the receptor at night is considered to be low, resulting in a **negligible** effect.

Visual effects – sensitivity test for programme delay

11.5.48 Para. 11.3.13 describes other developments assumed to be under construction at the same time as construction would be taking place at the Greenwich Pumping Station site. These are assessed cumulatively (Section 11.7). In the event that there is a programme delay of one year of the Thames Tideway Tunnel project, and assuming no change in the assumed rate of progress of the other developments, this would result in a re-categorisation of the Creekside Village East development from the cumulative assessment into base case. This would therefore introduce additional visual receptors with a view of the proposed development during construction.

11.6 Operational effects assessment

11.6.1 Operational effects have not been assessed on the basis that the limited changes in operation (comprising machinery within the existing pumping station building, minor improvements to the facade of the East Beam Engine House, limited areas of new planting and wildflower meadow, a shaft elevated above existing ground levels by approximately 1m and no operational lighting) would have no significant effects.

11.7 Cumulative effects assessment

11.7.1 As described in para. 11.3.13, the Creekside Village East development would be under construction during Site Year 2 of construction at the Greenwich Pumping Station site.

11.7.2 Cumulatively, construction activity at the Greenwich Pumping Station site and the Creekside Village East development would elevate effects on the setting of Creekside Industrial TCA and on visual receptors represented by viewpoints 1.1 and 1.4.

11.7.3 Effects during daytime on these receptors (which are considered negligible from the Thames Tideway Tunnel project alone) would be elevated but would remain not significant when taking into account construction at Creekside Village East. Effects during night time would not be altered.

11.7.4 In the event that the programme for the Thames Tideway Tunnel project is delayed by approximately a year, the Creekside Village East development would be assumed to be complete and operational. Therefore, there would be no cumulative effects.

11.8 Mitigation

11.8.1 All measures embedded in the proposed scheme and *CoCP* of relevance to the townscape and visual assessment are summarised in para. 11.2.3. No further mitigation during construction is possible due to the highly visible nature of the construction activities.

11.9 Residual effects assessment

Construction effects

11.9.1 As no mitigation measures are proposed, the residual construction effects remain as described in Section 11.5. All residual effects are presented in Section 11.10.

11.10 Assessment summary

Vol 24 Table 11.10.1 Townscape – summary of construction assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
The site	Change to the character of the site due to the removal of existing structures and trees, and the presence of construction activity, welfare facilities, the noise shed and site hoardings.	Minor adverse	None	Minor adverse
Creekside Industrial TCA	Change to immediate setting due to the presence of construction activity and site hoardings.	Minor adverse	None	Minor adverse
Ashburnham Triangle Conservation Area TCA	Change to setting due to increased HGV traffic and the presence of site hoardings.	Minor adverse	None	Minor adverse

Vol 24 Table 11.10.2 Visual – summary of construction assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
London View Management Framework London Panoramas				
London Panorama 6A.1 – Blackheath Point to St Paul's Cathedral	Visibility of the noise shed and cranes and slight visibility of construction activity, partially obscuring middle ground views of St Paul's Church Deptford.	Minor adverse	None	Minor adverse
	At night, barely perceptible visibility of lighting	Negligible	None	Negligible
Residential				
Viewpoint 1.1: View southwest	Background visibility of cranes.	Negligible	None	Negligible

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
from residences on Norman Road	At night, barely perceptible visibility of lighting	Negligible	None	Negligible
Viewpoint 1.2: View west from residences on Greenwich High Road close to the junction with Egerton Drive	Visibility of site hoardings, stacked welfare facilities and road transport.	Moderate adverse	No mitigation possible	Moderate adverse
	At night, barely perceptible visibility of lighting	Negligible	None	Negligible
Viewpoint 1.3: View northeast from residences on Greenwich High Road close to the junction with Burgos Grove	Visibility of increased levels of HGV traffic	Negligible	None	Negligible
	At night, barely perceptible visibility of lighting	Negligible	None	Negligible
Viewpoint 1.4: View southeast from residences on Berthon Street	Background visibility of cranes.	Negligible	None	Negligible
	At night, barely perceptible visibility of lighting	Negligible	None	Negligible
Viewpoint 1.5: View north from newly built residences in the 43-81 Greenwich High Road development (base case scheme)	Visibility of site hoardings, the noise shed, construction plant, traffic and cranes.	Moderate adverse	None	Moderate adverse
	At night, high visibility of capped and directional lighting.	Minor adverse	None	Minor adverse
Viewpoint 1.6: View west from newly built residences in the Greenwich Industrial Estate development (base case scheme)	Visibility of site hoardings, the noise shed, construction plant, traffic and cranes.	Moderate adverse	No mitigation possible	Moderate adverse
	At night, high visibility of capped and directional lighting.	Minor adverse	None	Minor adverse
Recreational				
Viewpoint 2.1: View southwest from the footbridge over Deptford Creek	Foreground visibility of site hoardings, construction activity, the noise shed and cranes, partially obscured by the DLR	Moderate adverse	No mitigation possible	Moderate adverse

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
	viaduct.			
	At night, foreground visibility of capped and directional lighting, beyond the site hoardings.	Minor adverse	None	Minor adverse
Transport				
Viewpoint 3.1: View south from Norman Road, north of the railway	Visibility of increased levels of HGV traffic and removal of mature trees.	Minor adverse	None	Minor adverse
	At night, barely perceptible visibility of lighting	Negligible	None	Negligible
Viewpoint 3.2: View west from Greenwich Station	No significant visibility of construction.	Negligible	None	Negligible
	At night, barely perceptible visibility of lighting	Negligible	None	Negligible
Employment				
Viewpoint 4.1: View west from industrial premises along Deptford Creek	Foreground visibility of site hoardings, construction activity, the noise shed and cranes.	Minor adverse	None	Minor adverse
	At night, barely perceptible visibility of lighting	Negligible	None	Negligible

References

[1] Department of Environment, Food and Rural Affairs. *National Policy Statement for Waste Water* (2012). Available at: http://www.defra.gov.uk/publications/files/pb13709-waste-water-nps.pdf. Last accessed November 2012.

[2] Royal Borough of Greenwich. *Unitary Development Plan* (2006).

[3] London Borough of Lewisham. *LDF Core Strategy* (June 2011).

[4] Royal Borough of Greenwich. *Ashburnham Triangle Conservation Area Character Appraisal and Management Strategy* (December 2008).

[5] Royal Borough of Greenwich. *West Greenwich Conservation Area Character Appraisal* (no date).

[6] London Borough of Lewisham. *Deptford Creekside Conservation Area Appraisal* (May 2012).

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

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.24**

Volume 24: Greenwich Pumping Station site assessment

Section 12: Transport

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Environmental Statement

Volume 24: Greenwich Pumping Station 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 Greenwich Pumping Station 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. Docklands Light Railway (DLR) and National Rail services

e. 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 both existing and proposed residents in the vicinity of the site. There are no river services in the vicinity of the Greenwich Pumping Station site and it is not proposed to use the river to transport materials at this site; therefore, effects on river passenger services and river navigation are not considered at this site.

12.1.4 The operation of the Greenwich Pumping Station site has the potential to affect highway layout and operation and therefore effects on these are considered within the operational assessment.

12.1.5 The assessment of transport presented in this section has considered the requirements of the National Policy Statement for Waste Water (Defra, 2012)[1] section 4.13. Further details of these requirements can be found in Vol 2 Section 12.3.

12.1.6 Additionally, a separate *Transport Assessment* has been produced which provides an assessment of the effects on the transport network as a result of the construction and operational phases at the Greenwich Pumping Station site. The *Transport Assessment* will accompany 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 24 Greenwich Pumping Station 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 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 construction site would be located within the existing Greenwich Pumping Station and surrounding land. Vehicle access to and from the site would take place from existing and new access points on Greenwich High Road (A206) and Norman Road (B208).

12.2.3 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 Greenwich Pumping Station and other Thames Tideway Tunnel project construction sites with construction routes along Norman Road (B208) and Greenwich High Road (A206), as well as the realignment of a shared foot and cycle path.

12.2.4 Details of the peak year of construction, anticipated lorry movements and the activities which would generate these movements are provided in Vol 24 Table 12.2.1.

Vol 24 Table 12.2.1 Transport – construction traffic details

Description	Assumption
Assumed peak period of construction lorry movements	Site Year 3 of construction
Assumed average peak daily construction lorry vehicle movements (in peak month of Site Year 3 of construction)	154 movements per day (77 vehicle trips)
Typical types of lorry requiring access (comprising rigid-bodies, flatbed and articulated vehicles)	Excavation lorries Tunnel precast concrete linings lorries Imported fill lorries Aggregate lorries Cement tankers lorries Ready mix mixer lorries Steel reinforcement lorries Office delivery lorries Plant and equipment lorries Temporary construction material lorries including pipe/track/oils/greases lorries

Note: a movement is a construction vehicle moving either to or from the 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

12.2.5 During construction all materials would be transported by road.

12.2.6 Although this site would have 24-hour working during tunnelling and the secondary lining phase, vehicle movements would only 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). Extended working hours up to 22.00 are required for large concrete pours during shaft construction. It is only in exceptional circumstances that HGV and abnormal load movements could occur up to 22:00 on weekdays or later at night on agreement with the Royal Borough (RB) of Greenwich.

Construction traffic routing

12.2.7 The access plan and highway layout during construction plan (see separate volume of figures – Section 1) present the highway layout during construction.

12.2.8 The Greenwich Pumping Station site is approximately 350m from the nearest Transport for London Road Network (TLRN) route on Blackheath Road (A2) and Deptford Bridge (A2), and approximately 470m from the nearest part of the Strategic Road Network (SRN) on Creek Road (A200).

12.2.9 The construction site would be located within the existing Thames Water Greenwich Pumping Station and on adjacent land. Vehicle access to and from the site would take place from Greenwich High Road (A206) and Norman Road (B208) using existing and new access points.

12.2.10 The proposed routing strategy for construction vehicles in all phases at Greenwich Pumping Station would be to and from Blackheath Road (A2) and Deptford Bridge (A2) via Greenwich High Road (A206) and Norman Road (B208).

12.2.11 Vol 24 Figure 12.2.1 (see separate volume of figures) shows the construction traffic routes for access to and from Greenwich Pumping Station. Construction routes have been discussed with both Transport for London (TfL) and the Local Highway Authority (LHA), the RB of Greenwich for the purposes of the assessment.

Construction workers

12.2.12 The construction site is expected to require a maximum workforce of approximately 165 workers at any one time. The number and type of workers is shown in Vol 24 Table 12.2.2. It is noted that the table shows the maximum number of workers required (289), however, as a result of shift patterns the maximum workforce on site would be 165 occurring during the dayshift (08:00-18:00).

Vol 24 Table 12.2.2 Transport – maximum estimated construction worker numbers

Contractor					Client	
Staff*		Labour**			Staff***	
08:00-18:00	18:00-08:00	08:00-15:00	15:00-23:00	23:00-08:00	08:00-18:00	18:00-08:00
60	15	60	60	45	45	4

**Staff Contractor – engineering and support staff to direct and project manage the engineering work and site.*
***Labour – those working on site doing engineering, construction and manual work.*
****Staff Client – engineering and support staff managing the project and supervising the Contractor.*

12.2.13 At the Greenwich Pumping Station 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 24 Table 12.5.1.

Code of Construction Practice

12.2.14 Measures incorporated into the *Code of Construction Practice* (*CoCP*)[i] *Part A* (Section 5) to reduce transport effects include:

a. site specific *Traffic Management Plans* (*TMP*): to set out how vehicular access to the site would be managed so as to minimise impact on the local area and communicate this with the local borough and other stakeholders. This includes any works on the highway, diversion or temporary closure of the highway or public right of way

b. HGV management and control: to ensure construction vehicles use appropriate routes to the sites and the vehicle fleet and/or drivers meet current safety and environmental standards.

12.2.15 In addition to the general measures within the *CoCP Part A*, the *CoCP Part B* (Section 5) relating to the Greenwich Pumping Station site includes the following site-specific measures:

a. the overall site is separated into a number of areas around the existing operating Pumping Station. Each access is required to have adequate security arrangements

b. at the main site entrances the security barrier would be positioned to allow a standard rigid tipper vehicle to be wholly off the road while awaiting barrier operation

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

c. construction traffic would access the site from Greenwich High Road (A206) and Norman Road (B208), from the direction of Blackheath Road (A2). Traffic would egress via the same routes

d. the existing entrance to the site from Greenwich High Road (A206) would be restricted to cars and light goods vehicles apart from during site set-up and removal. The entrance is shared with Thames Water Operations access to the Pumping Station

e. the site layout would ensure that lorries can turn on site and no reversing onto the adjacent roads is required. Any exceptions such as abnormal loads would be agreed in advance.

f. the existing public footpath from Norman Road (B208) to Creekside would be realigned and suitable access for disabled users would be maintained unless agreed otherwise with the local authority.

12.2.16 The effective implementation of the *CoCP Part A* and *Part B* measures is assumed within the assessment.

12.2.17 Based on current travel planning guidance including TfL's 'Travel Planning for new development in London (TfL, 2011)[2], this development falls within the threshold for producing a Strategic Framework Travel Plan. A *Draft Project Framework Travel Plan* has been prepared based on the TfL ATTrBuTE guidance (TfL, 2011)[3]; this will accompany the application. The *Draft Project Framework Travel Plan* addresses project-wide travel planning measures, including the need for a project-wide Travel Plan Manager, initial travel surveys during construction and a monitoring framework. It also contains requirements and guidelines for the site-specific *Travel Plans* to be prepared by the site contractors. The site-specific travel planning requirements of relevance to the *Draft Project Framework Travel Plan* are as follows:

a. information on existing transport networks and travel initiatives for the Greenwich Pumping Station site including shuttle bus services for staff and labour

b. a mode split established for the Greenwich Pumping Station 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.

Operation

12.2.18 During operation, access for maintenance vehicles to the Greenwich Pumping Station site would be via an existing access point to the Thames Water facility, on Norman Road (B208), as detailed in the Greenwich Pumping Station design principles report Section 4.20 (see Vol 1 Appendix B). Access would be required for a light commercial vehicle on a three to six monthly maintenance schedule. Additionally there would be more substantive maintenance visits at approximately ten year intervals requiring access to enable two mobile cranes and associated support vehicles to be brought to the site.

12.3 Assessment methodology

Engagement

12.3.1 Volume 2 documents the overall engagement which has been undertaken in preparing the *Environmental Statement*. Specific comments relevant to this site for the assessment of traffic and transport are presented in Vol 24 Table 12.3.1.

12.3.2 It is noted that it was reported in the *Scoping Report* that operational traffic effects for the project as a whole were scoped out of the 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 24 Table 12.3.1 Transport – stakeholder engagement

Organisation	Comment	Response
RB of Greenwich Borough meeting, July 2012 Phase two consultation, February 2012	The junction of Greenwich High Road (A206) and Norman Road (B208) should be reviewed to determine if there is sufficient capacity.	Transport modelling has been undertaken to understand the capacity of the local highway network and the impact of the Thames Tideway Tunnel project on the network (see Section 12.5). This includes the junction of Greenwich High Road (A206) and Norman Road (B208).
RB of Greenwich Borough meeting, July 2012 Phase two consultation, February 2012	Assess each access/egress point for construction vehicles.	This forms part of the transport assessment (see Section 12.5).
RB of Greenwich Borough meeting, July 2012 Phase two consultation, February 2012	One-way system through site is preferred.	This forms part of the site design.
RB of Greenwich Borough meeting, July 2012 Phase two	Check proximity of exit to existing signal junctions.	This has been taken into consideration within the design and assessment. There is sufficient distance

Organisation	Comment	Response
consultation, February 2012		between the signal junction of Greenwich High Road (A206) and Norman Road (B208) and the proposed access points.
RB of Greenwich Borough meeting, July 2012 Phase two consultation, February 2012	Additional site to north for excavated material could reduce trips between sites.	Movements between the construction area to the north of the DLR / National Rail and the construction area to the south of the viaduct would be internal movements and would not use Norman Road (B208).
RB of Greenwich Borough meeting, July 2012 Phase two consultation, February 2012	Pedestrian access to Deptford Creek adjacent to worksite will need to be maintained if site is extended further to north.	As part of the proposed design the route would be maintained and appropriately separated from construction site activities.
RB of Greenwich Borough meeting, July 2012 Phase two consultation, February 2012	Impact on bus journey times minimal, with current highway arrangement. Should Norman Road (B208) be modified to one-way this may change bus routing.	It is understood that the Borough is not promoting one way operation in Norman Road (B208) and there is no committed scheme to do so at the time of writing.
RB of Greenwich Borough meeting, July 2012 Phase two consultation, February 2012	Effects of low bridge (Creek Road) on use of barges to transport material.	As set out in the *Transport Strategy*, the proposals at the Greenwich Pumping Station site are for the transport of materials by road to/from this site.
RB of Greenwich Borough meeting, July 2012 Phase two consultation, February 2012	Check feasibility of footpath grading to ensure it is accessible for wheelchair users.	This has been addressed in the design. Any alteration to the footpath between Norman Road (B208) and Creek Road would be suitable for wheelchair users.
RB of Greenwich Borough meeting, July 2012 Phase two consultation, February 2012	Evaluate direction of construction vehicles along Norman Road (B208). Demonstrate it is preferable for vehicles to go south onto Greenwich High Road (A206) rather than north onto Creek Road.	This has been assessed in the strategic and local modelling assessments. Construction traffic would be routed via Norman Road (B208) and Greenwich High Road (A206).

Organisation	Comment	Response
RB of Greenwich Borough meeting, July 2012 Phase two consultation, February 2012	Confirm to Thames Tideway Tunnel the need for signal optimisation to improve pedestrian crossing time and junction capacity, especially on Greenwich High Road (A206).	This has been addressed in the local modelling analysis and it is assumed that signal optimisation would be carried out by TfL as part of their network management duty.
RB of Greenwich, Borough meeting, July 2012, April 2011	Proposed one-way project in Norman Road (B208), including signal gating on Norman Road (B208) / Greenwich High Road (A206) could possibly restrict entry	It is understood that the Borough's original proposals for this have been put on hold. The Borough is considering whether the scheme might be promoted following the London 2012 Olympic and Paralympic Games, which would introduce temporary one-way operation in Norman Road (B208). However there are no firm proposals and therefore this is not considered in this assessment.
RB of Greenwich, phase two consultation, February 2012	The use of the river to transport materials to and from the site should be fully investigated.	This has been investigated and assessed as part of the *Transport Strategy*. The proposals at the Greenwich Pumping Station site are for the transport of materials by road to/from this site.
RB of Greenwich, phase two consultation, February 2012	No construction traffic should be directed through the town centre, the preferred route is to turn right out of the site and then head towards the A2.	Construction routing proposals for the site assume lorries would not be routed through Greenwich town centre.
RB of Greenwich, phase two consultation, February 2012	Concern is expressed about maintaining the footway and cycleway to Ha'penny Hatch Bridge.	This has been taken into consideration within the design and assessment. The route via Ha'penny Hatch Bridge would be maintained through realignment during construction.
RB of Greenwich, phase two consultation, February 2012	The vehicular access under the DLR railway bridge should be altered in the interest of pedestrian safety.	This has been taken into consideration within the design and assessment. The vehicular access would be

Organisation	Comment	Response
		maintained and the interface between pedestrians, cyclists and construction vehicles would be managed by construction staff.
RB of Greenwich, phase two consultation, February 2012	It will need to be demonstrated that there is sufficient space for articulated vehicles to manoeuvre.	Swept path analysis has been carried out which demonstrate that articulated vehicles would be able to manoeuvre within the proposed site design (see Section 12.5).
RB of Greenwich, phase two consultation, February 2012	A Travel Plan should be provided.	A *Draft Project Framework Travel Plan* has been prepared which will accompany the application.

Baseline

12.3.3 The baseline methodology follows the methodology described in Vol 2 Section 12. 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 Section 12. 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 Greenwich Pumping Station 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 24 Appendix N), all of the other developments identified within 1km of the Greenwich Pumping Station site would be complete and operational by Site Year 3 of construction and therefore form part of the base case. These developments are:

a. Block E, 43-81 Greenwich High Road (A206)

b. 83-87 Greenwich High Road (A206)

c. Greenwich Industrial Estate

d. Hilton’s Wharf

e. Development on site of old Seagar Distillery and Norfolk House

f. Greenwich Reach East

g. Bardsley Lane development

h. Development on land at Stockwell Street and John Humphries House

i. Development on land opposite North Greenwich Pier.

12.3.7 The Creekside Village East and Heathside and Lethbridge developments would be under construction in Site Year 3 of construction. This means that the transport assessment should consider cumulative effects in relation to those developments. However, the TfL Highway Assignment Models (HAM) which have been used in the *Transport Assessment* have been developed using Greater London Authority (GLA) employment and population forecasts, based on the employment and housing projections set out in the London Plan (Greater London Authority, 2011) [4]. As a result the assessment inherently takes into account a level of future growth and development across London.

12.3.8 This means that the trips associated with the developments detailed above are already taken into consideration within the traffic modelling.

Construction assessment area

12.3.9 The assessment area for the Greenwich Pumping Station site includes the site accesses directly from Norman Road (B208) and Greenwich High Road (A206) and the Greenwich High Road (A206) / Norman Road (B208) junction.

12.3.10 These roads and the junction have been assessed for highway, cycle and pedestrian impacts. Effects on local bus services within 640m of the site and rail services within 960m of the site have also been assessed[ii].

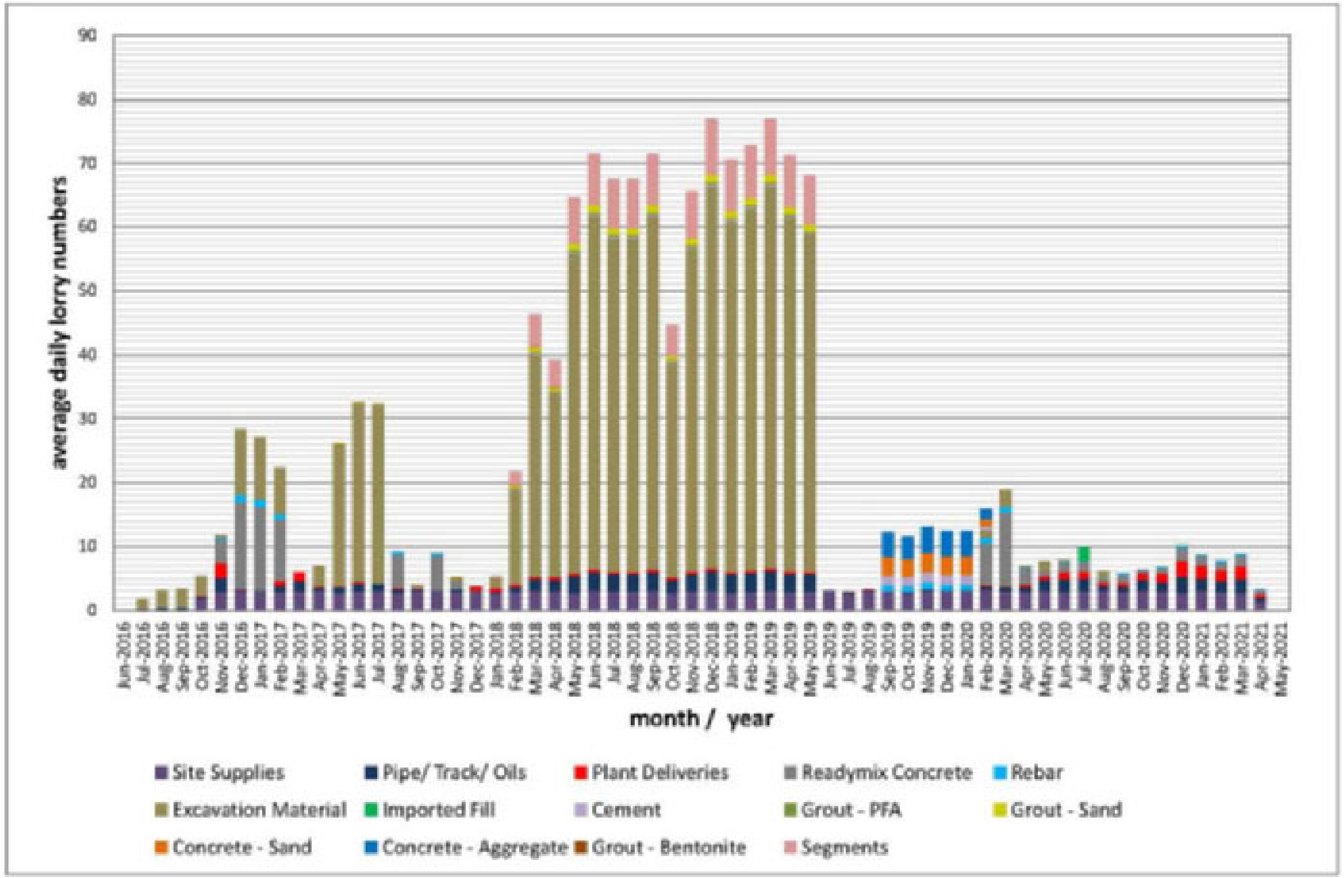
Construction assessment year

12.3.11 A site-specific peak construction assessment year has been identified. The histogram in Vol 24 Plate 12.3.1 shows that the peak site-specific activity at the Greenwich Pumping Station site would occur in Site Year 3 of construction.

12.3.12 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.

[ii] Distances derived from the Public Transport Accessibility Level (PTAL) methodology described in Volume 2.

Vol 24 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.

Operation

12.3.13 The assessment methodology for the operational phase follows that described in Vol 2 Section 12. There are no site specific variations for undertaking the operational assessment of this site.

12.3.14 Once the Thames Tideway Tunnel project is operational it is not expected that there would be any significant effects on the transport infrastructure and operation within the local area because maintenance trips to the Greenwich Pumping Station site would be infrequent and short-term, and often combined with visits to the existing pumping station. On this basis it is not necessary to assess the effects on all the elements listed at para. 12.1.2. The only element considered is the effect on highway layout and operation.

12.3.15 These elements are considered qualitatively (as described in Vol 2 Section 12) because the minimal effect on the highway network means that a quantitative assessment is not required. The scope of this analysis has been agreed with the RB of Greenwich and TfL.

12.3.16 Also, given the local impact of the transport activity associated with the Thames Tideway Tunnel project during the operational phase, only the localised transport effects around the Greenwich Pumping Station site are assessed. Other Thames Tideway Tunnel project sites would not affect the area around Greenwich Pumping Station in the operational phase and therefore they are not considered in the assessment.

12.3.17 With regard to other developments in the vicinity of the site (as detailed in the site development schedule, see Vol 24 Appendix N), all the developments would be complete and operational by Year 1 of operation (forming part of the operational base case) with the exception of the Heathside and Lethbridge Estate redevelopment which would still be under construction.

Operational assessment area

12.3.18 The assessment area for the operational assessment remains the same as for the construction assessment as set out in paras. 12.3.9 and 12.3.10.

Operational assessment year

12.3.19 As outlined in Vol 2 Section 12 the operational assessment year has been taken as Year 1 of operation. As transport activity associated with the operational phase is very low, there is no requirement to assess any other year beyond that date.

12.3.20 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

12.3.21 The general assumptions and limitations associated with this assessment are presented in Vol 2 Section 12.

Assumptions

12.3.22 Local junction modelling for the construction base and development cases at this site has incorporated traffic signal optimisation on the basis that this would be implemented as necessary by TfL (as part of routine management) to ensure the effective operation of the highway network and respond to changes in traffic conditions.

12.3.23 There would be deliveries of fuel for construction plant to this site and a number of construction products may be classified as hazardous. For the Greenwich Pumping Station site, it is assumed that there would be two hazardous loads per week generated by the site.

12.3.24 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

12.3.25 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 site is located within the existing Greenwich Pumping Station and on adjacent land, and lies within the RB of Greenwich as shown in Vol 24 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 24 Figure 12.4.2 (see separate volume of figures).

12.4.4 Greenwich High Road (A206) has footways of between 1m and 4.8m in width on both sides of the single carriageway, providing a continuous northeast-southwest link between Nelson Road (A206) and Greenwich town centre to the northeast and Blackheath Road (A2) and Deptford Bridge (A2) to the southwest.

12.4.5 Norman Road (B208) has footways of between 2.4m and 3.6m in width on both sides of the road. The road provides a north-south link between Creek Road (A200) to the north and Greenwich High Road (A206) to the south.

12.4.6 There is a shared pedestrian and cycle footway which links Norman Road (B208) to the east and Creekside to the west. The footway runs alongside the National Rail viaduct across the creek via Ha'penny Hatch bridge and passes under the DLR viaduct and through the site.

12.4.7 The junction of Greenwich High Road (A206) and Norman Road (B208) is signalised and includes a pedestrian crossings with refuge islands and dropped kerbs to the east of the junction. There is also a pedestrian refuge island on Greenwich High Road (A206), 5m to the south of the entrance to Greenwich Pumping Station.

12.4.8 The Thames Path runs on the north side of Creek Road (A200) to the west of the junction with Norman Road (B208), approximately 680m away from the site to the north. The Thames Path continues to the east along Norway Street and Thames Street and to the west along Creek Road (A200) and continues north along Stowage and Glaisher Street.

Cycle facilities and routes

12.4.9 The existing cycle network and facilities in the vicinity of the site are shown in Vol 24 Figure 12.4.2 (see separate volume of figures).

12.4.10 As described above, there is a shared pedestrian and cycle footway to the north of the entrance to Greenwich Pumping Station on Norman Road (B208). This runs through the site and across the creek and links to National Cycle Route 21 on Creekside.

12.4.11 National Cycle Route 21 runs to the west and south of the site on a traffic free route alongside Brookmill Road (A2210). It passes over Deptford Bridge (A2) before continuing on-road along Creekside where it joins National Cycle Route 4 (Tower Bridge to Greenwich) in the north.

12.4.12 There are no Cycle Superhighways (CS) in the vicinity of the site.

12.4.13 The closest cycle parking facilities are located on the northern footway of Greenwich High Road (A206) to the west of the junction with Norman Road (B208) with two cycle stands provided. A further 16 cycle stands capable of accommodating up to 32 bicycles are provided outside Greenwich DLR and Greenwich Rail Station on Greenwich High Road (A206) and Tarves Way.

Public Transport Accessibility Level

12.4.14 The Public Transport Accessibility Level (PTAL) of the site has been calculated using TfL's approved PTAL methodology (TfL, 2010)[5] and assumes a walking speed of 4.8km/h and considers rail stations within a 12 minute walk (960m) of the site and bus stops within an eight minute walk (640m).

12.4.15 Using this methodology the site has a PTAL rating of 4, rated as 'good' (with 1 being the lowest accessibility and 6b being the highest accessibility).

12.4.16 Vol 24 Figure 12.4.3 (see separate volume of figures) shows the public transport network around the Greenwich Pumping Station site.

Bus routes

12.4.17 As shown in Vol 24 Figure 12.4.3 (see separate volume of figures), a total of seven daytime bus routes and two night bus routes operate within a 640m walking distance of the site.

12.4.18 The bus routes operate from the following bus stops:

a. Miller House bus stop on Greenwich High Road (A206) - northbound and southbound, 55m walking distance to the south

b. Greenwich Station bus stop on Greenwich South Street (A2211) - northbound and southbound, 416m walking distance to the northeast

c. Deptford Bridge bus stop on Deptford Bridge (A2) - eastbound and westbound, 428m walking distance to the southwest

d. Creek Road / Norman Road on Creek Road (A200) - eastbound and westbound, 488m walking distance to the northeast

12.4.19 These routes would also serve other stops further from the site as shown on Vol 24 Figure 12.4.3 (see separate volume of figures).

12.4.20 On average there are 84 daytime bus services in total per hour in the AM peak and 86 bus services in total per hour in the PM peak within a 640m walking distance of the site.

12.4.21 There are approximately six night time bus services per hour Monday – Friday between 00:00 – 06:00 and a total of nine night-time bus services per hour on Saturdays between 00:00 – 06:00 within 640m walking distance of the site.

Docklands Light Railway (DLR)

12.4.22 Greenwich is the nearest Docklands Light Railway (DLR) station to the site. As shown on Vol 24 Figure 12.4.3 (see separate volume of figures), the station is located approximately 300m walking distance to the east of the site.

12.4.23 The DLR from Greenwich provides services between Lewisham and Bank, and Lewisham and Stratford as well as allowing interchange at Poplar for other eastern destinations. Services operate at AM and PM peak frequencies of approximately every four minutes. This equates to approximately 15 trains per hour in each direction. The same services can also be accessed at Cutty Sark DLR station, approximately 700m to the northeast of the site.

National Rail

12.4.24 Greenwich also provides National Rail services and is located approximately 300m walking distance to the east of the site. The station is served by Southeastern train services to and from London Charing Cross, London Cannon Street, London Bridge, Dartford, Slade Green, Barnehurst, Gillingham (Kent), Gravesend and Crayford.

12.4.25 In the AM and PM peak hours there are approximately 30 and 28 services calling at Greenwich station respectively.

Parking

12.4.26 Vol 24 Figure 12.4.4 (see separate volume of figures) shows the locations of the existing car parks and car club spaces within the vicinity of the site.

Existing on-street car parking

12.4.27 There are 19 marked parking bays along Norman Road (B208), 14 are reserved for resident and business permit holders only and five are metered parking bays.

12.4.28 A total of 296 resident permit holder parking bays are available on Ashburnham Grove, Ashburnham Place, Claremont Street, Devonshire Drive, Egerton Drive, Greenwich High Road (A206), Haddo Street, Langdale Road, Randall Place and Tarves Way.

12.4.29 Additionally there are 34 pay and display parking bays on roads in the immediate vicinity of the site.

Coach parking

12.4.30 Two coach parking bays are provided along Norman Road (B208) between the junction with Tarves Way and the junction with Thornham Street approximately 500m walking distance northeast from the site. A further coach parking bay is located on Stockwell Street approximately 750m walking distance to the northeast of the site.

Car clubs

12.4.31 There are two car club parking spaces on Devonshire Drive, located approximately 120m walking distance to the southeast of the site.

Servicing and deliveries

12.4.32 A loading / blue badge holder parking bay is located along Greenwich High Road (A206) (northbound) to the north of the junction with Deptford Bridge (A2) and Blackheath Road (A2) approximately 360m walking distance to the southwest of the site.

Highway network and operation

12.4.33 The site is located within the existing Greenwich Pumping Station site as shown in Vol 24 Figure 12.4.1 (see separate volume of figures).

12.4.34 To the south of the site is Greenwich High Road (A206), a single carriageway with one lane per direction and speed limit of 30mph. Greenwich High Road (A206) provides a continuous northeast-southwest link between Nelson Road (A206) and Greenwich town centre to the northeast and Blackheath Road (A2) and Deptford Bridge (A2) to the southwest.

12.4.35 To the south, Greenwich High Road (A206) links to Blackheath Road (A2) and Deptford Bridge (A2) at a signalised junction, 370m to the southwest of the site. Both Blackheath Road (A2) and Deptford Bridge (A2) are part of the TLRN.

12.4.36 Greenwich High Road (A206) and Greenwich South Street (A2211) meet at a signalised junction 380m to the northeast of the site. Greenwich South Street (A2211) is a single carriageway with one lane per direction and a speed limit of 30mph. The road provides a northeast-southwest link between Blackheath Road (A2) and Blackheath Hill (A2) to the south and Greenwich High Road (A206) to the north.

12.4.37 To the east of the site, Norman Road (B208) provides a north-south link between Creek Road (A200) to the north and Greenwich High Road (A206) to the south. To the north, Creek Road (A200) links to the TLRN towards Bermondsey. Norman Road (B208) is a two-way road with one lane per direction and a speed limit of 30mph. Greenwich High Road (A206) and Norman Road (B208) meet at a signalised junction.

Data from third party sources

Description of data

12.4.38 Five years of accident data on the roads within the vicinity of the site have been sourced from TfL.

Accident analysis

12.4.39 A total of 41 accidents occurred in the vicinity of the site over the five years of accident data analysed. Of these accidents, 31 were classified as slight and ten as serious.

12.4.40 During the five year period, the largest number of road traffic accidents occurred at the junction of Greenwich High Road (B206) / Deptford Bridge (A2) / Blackheath Road (A2), and the junction of Creek Road (A200) / Norman Road (B208) / Haddo Street. Most of the accidents which occurred at these two junctions were classified as slight, with six serious accidents.

12.4.41 Of pedestrians and cyclists that were involved in accidents, three pedestrian and 12 cyclist accidents were classed as serious. Ten pedestrians were also involved in slight accidents.

12.4.42 Of the total accidents, eight accidents occurred in the assessment area which involved LGVs, MGVs, and HGVs. All these accidents were classified as slight accidents.

12.4.43 Of the five years of accident data analysed none of the accidents happened as a result of the road geometry.

Survey data

Description of surveys

12.4.44 Baseline survey data for Greenwich Pumping Station were collected in May 2011 to establish the existing transport movements and parking usage in the area. Volume 24 Figure 12.4.5 (see separate volume of figures) shows the survey locations in the vicinity of the site.

12.4.45 As part of surveys in May 2011, manual and automated traffic surveys were also undertaken to establish specific traffic, pedestrian and cycle movements including turning volumes, queue lengths, saturation flows, degree of saturation and traffic signal timings. Parking surveys were undertaken to establish the usage of pay and display and metered parking in addition to coach parking and resident parking.

Results of the surveys

12.4.46 The surveys inform the baseline situation in the area surrounding the site.

Pedestrians and cyclists

12.4.47 Pedestrian surveys on the pedestrian crossing located on Greenwich High Road (A206) to the east of the junction with Norman Road (B208) indicate that during the AM peak hour the flow is heavier with approximately 158 northbound pedestrians and eight southbound pedestrians. During the PM peak hour, there is a relatively balanced flow of pedestrians of approximately 30 pedestrians in each direction.

12.4.48 The cycle flows along Greenwich High Road (A206) and Norman Road (B208) indicate that along Greenwich High Road (A206) there is a reasonably balanced flow in the southwest direction during the peak periods, but the northeast direction has 71 heading northeast and 40 heading southwest during the AM peak hour and 29 riders cycling northeast and 41 cycling southwest in the PM peak hour. Flows along Norman Road (B208) showed 28 heading north and five south during the AM peak hour. During the PM peak hour five travel north and 15 travel south.

Traffic flows

12.4.49 The traffic flows for the busiest period (weekday AM and PM peak hours) within the area are shown in Vol 24 Figure 12.4.6 and Vol 24 Figure 12.4.7 (see separate volume of figures).

12.4.50 Traffic surveys indicate that there is a total two-way traffic flow of 527 and 509 during the AM and PM peak hours respectively along Greenwich High Road (A206). During both peak hours there is a predominant flow of traffic heading northeast.

Parking

12.4.51 The results of the parking surveys indicate that usage of resident, pay and display and metered parking bays along Greenwich High Road (A206), Norman Road (B208) and the surrounding area is heavy although there is still spare capacity available on both weekdays and at weekends during the peak and off-peak periods.

12.4.52 Surveys were also undertaken to establish the availability of coach parking along Norman Road (B208) to understand existing occupancy and capacity. Results indicate there is ample capacity as the coach parking spaces along Norman Road (B208) are not heavily used for the majority of the day.

Local highway modelling

12.4.53 To establish the existing capacity on the local highway network, a scope was discussed with the RB of Greenwich and TfL to model the Greenwich High Road (A206) / Norman Road (B208) junction using a LinSig model. The baseline model represents the current traffic and transport conditions within the vicinity of the site.

12.4.54 The weekday AM and PM baseline model flows for the junction were compared against observed queue lengths for the peak periods (using junction surveys) to validate the model and ensure reasonable representation of existing conditions. Vol 24 Table 12.4.1 shows the modelling outputs which demonstrate that the network is currently operating well below the theoretical maximum capacity in the weekday AM peak hour and above capacity during the PM peak hour. The model indicates that the longest queue and greatest delay is during the PM peak hour on Norman Road (B208) which currently experiences an average of 106 seconds of delay per PCU.

Vol 24 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 (PCUs)	DoS	MMQ (PCUs)	Delay per PCU (seconds)	Flow (PCUs)	DoS	MMQ (PCUs)	Delay per PCU (seconds)
Greenwich High Road (A206) east	Ahead	224	21%	2	9	177	18%	2	9
	Right	0	0%	0	0	0	0%	0	0
Greenwich High Road (A206) west	Ahead / left	262	36%	3	17	332	45%	5	18
Norman Road (B208) southbound	Right / left	106	29%	2	27	361	99%	14	106
		PRC		Total delay (PCU hours)		PRC		Total delay (PCU hours)	
Overall junction performance		152.2%		3		-9.5%		13.8	

Note: 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 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 2.3 PCUs. Buses and coaches are two PCUs. Motorcycles are 0.4 PCUs and pedal cycles are 0.2 PCUs.

Transport receptors and sensitivity

12.4.55 The receptors and their sensitivities in the vicinity of the Greenwich Pumping Station site are summarised in Vol 24 Table 12.4.2. The transport receptor sensitivity is defined as high, medium or low using the criteria detailed in Vol 2 Section 12.

12.4.56 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.

12.4.57 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 24 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 and cyclists (including sensitive pedestrians[iii]) on Greenwich High Road (A206) and Norman Road (B208)	Construction	High sensitivity to diversions, resulting in increases to journey time.
Private vehicle users in the area using the local highways or on-street parking	Construction Operation	Medium sensitivity to increases in HGV traffic resulting in journey time delays.
Emergency vehicles travelling on Greenwich High Road (A206) and Norman Road (B208)	Construction Operation	High sensitivity to journey time delays due to time constraints on journey purposes.

[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
Service vehicles using loading bay on Greenwich High Road (A206)	Construction	Low sensitivity due to distance from site.
Bus users (passengers) travelling along Greenwich High Road (A206)	Construction	Medium sensitivity to journey time delays as a result of increases to traffic flows.
Public transport users using DLR or rail services within the area	Construction	Low sensitivity due to distance from the site and low numbers of construction workers.
Patrons of public house, adjacent to the south of the site Residents of 43-81 Greenwich High Road, adjacent to the southwest of the site	Construction	High sensitivity to increases in HGV traffic and changes to pedestrian environment resulting in journey time delays.
Visitors and staff at newsagents, 450m to the south of the site	Construction	Medium sensitivity to increases in HGV traffic and changes to pedestrian environment resulting in journey time delays.
Users of Greenwich West Community and Arts Centre, 95m to the northeast of the site	Construction	Medium sensitivity to increases in HGV traffic and changes to pedestrian environment resulting in journey time delays.
Users of Devonshire Drive Baptist Church, 115m southeast of the site	Construction	Medium sensitivity to increases in HGV traffic and changes to pedestrian environment 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
Students and staff at Lewisham College (Deptford campus), 220m to the south of the site	Construction	Low sensitivity to increases in HGV traffic and changes to pedestrian environment resulting in journey time delays (due to distance from the site).

Construction base case

12.4.58 As described in Section 12.3, the construction assessment year for transport effects in relation to this site is Site Year 3 of construction.

12.4.59 A new walking and cycling route will be introduced linking Greenwich and Deptford stations, expected to be completed by 2012/13. The route will utilise a combination of existing infrastructure, notably the Ha'penny Hatch bridge, which carries the Norman Road (B208) to Creekside leg of the cycle route across Deptford Creek.

12.4.60 It is proposed that there will be changes to the cycling network by Site Year 3 of construction. By 2013 the Cycle Superhighway route five (CS5) will be opened, running from Lewisham to Victoria. It will travel east to west in the area of A2, some 270m to the southwest of the site. It is also proposed that by 2015 Cycle Superhighway route five (CS4) will be opened, running from Woolwich to London Bridge. The nearest approach to the site would be from Creek Road (A200), approximately 470m to the northeast of the site.

12.4.61 There are no proposals to alter DLR and National Rail services in the Greenwich area from the current baseline conditions and therefore the construction base case remains similar to the baseline position. It is envisaged that DLR and National Rail patronage will increase by Site Year 3 of construction.

12.4.62 In order to ensure that the busiest base case scenario is used in the assessment, the capacity for National Rail and DLR in the base case has been assumed to remain the same as capacity in the baseline situation. This ensures a robust assessment as outlined in Vol 2 Section 12.

12.4.63 Baseline traffic flows (from the junction surveys) have been used and forecasting carried out to understand the capacity on the highway network in the vicinity of the Greenwich Pumping Station site in Site Year 3 of construction without the Thames Tideway Tunnel project. The base case traffic flows (derived from the survey data) providing input to the LinSig model are shown on Vol 24 Figure 12.4.6 and Vol 24 Figure 12.4.7 (see separate volume of figures).

12.4.64 The key findings from the construction base case LinSig model indicate that the network will be operating below theoretical capacity on all the junction arms in the weekday AM and PM peak hours. There will be no change in queue length in the AM peak hour, however in the PM peak hour there will be an increase in queue length on the Greenwich High Road (A206) westbound arm. The queue length on the Norman Road (B208) southbound arm will decrease in the construction base case compared to baseline conditions. In the AM peak hour, the average delay per PCU will increase on the Norman Road (B208) southbound arm by two seconds and will reduce on the Greenwich High Road (A206) westbound arm by three seconds in the construction base case compared to baseline conditions. In the PM peak hour, on the Norman Road (B208) southbound arm, the average delay per PCU will reduce by 81 seconds and on the Greenwich High Road (A206) westbound arm, the average delay per PCU will increase by eight seconds. The reduction in queue length and delay on some arms will occur as a result of the traffic signal optimisation in the construction base case as detailed in Vol 2 Section12.

12.4.65 With regard to the identification of additional receptors associated with the other developments included in the base case, the following developments on the list provided in para. 12.3.6 are within 250m of the site:

a. redevelopment of Block E of 43-81 Greenwich High Road (A206) (change of use from office to hotel) – already included as a receptor in Vol 24 Table 12.4.2

b. development of 83-87 Greenwich High Road (A206) (mixed use commercial and residential scheme)

c. redevelopment of Greenwich Industrial Estate (mixed use residential, education, leisure and community uses)

d. Hilton's Wharf (mixed residential and office scheme).

12.4.66 Impacts could be experienced by residents, staff and visitors at these developments using the footways and the local highway network in the vicinity of the site and on this basis they have been taken into consideration as receptors in the assessment.

Vol 24 Table 12.4.3 Transport – construction base case additional receptors

Receptors (relating to developments within 1km of the site)	Phase at which receptor is sensitive to identified impacts	Value/sensitivity and justification
Residents and users of 83-87 Greenwich High Road (A206), adjacent to the site Residents and users of Greenwich Industrial Estate, adjacent to the site Residents and users of Hilton's Wharf, 35m north of the site	Construction	High sensitivity to increases in HGV traffic and changes to pedestrian environment resulting in journey time delays

Operational base case

12.4.67 The operational assessment year for transport is Year 1 of operation.

12.4.68 The elements of the transport network that would be affected during operation are highway layout and operation. For the purposes of the operational base case, it is anticipated that the highway layout will be as indicated in the construction base case.

12.4.69 The operational base case takes into account the developments described in the site development schedule (see Vol 24 Appendix N). The developments detailed in Vol 24 Table 12.4.3 above are within 250m of the Greenwich Pumping Station site, and would be complete by Year 1 of operation. However, given the limited effects which are anticipated in the operational phase, these developments do not present any additional transport receptors that require 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 Greenwich Pumping Station site (Site Year 3 of construction).

12.5.2 The anticipated mode split of worker trips for the Greenwich Pumping Station site is detailed in Vol 24 Table 12.5.1 and has been generated based on 2001 Census[iv] data for journeys to workplaces within the vicinity of Greenwich Pumping Station. The 2001 Census data indicates that the predominant mode of travel for journeys to work in this area would be by private car.

12.5.3 However, at this site there would be no parking provided within the site boundary for workers, parking on surrounding streets is also restricted and measures to reduce car use would be incorporated into site-specific Travel Plan requirements. It is therefore highly unlikely that workers would travel by car. The Census mode shares have therefore been adjusted in Vol 24 Table 12.5.1 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 24 Table 12.5.1 Transport – mode split

Mode	Percentage of trips to site	Equivalent number of worker trips (based on total 165 worker trips)	
		AM peak hour (07:00-08:00)	PM peak hour (18:00-19:00)
Bus	29%	48	31
National Rail	25%	41	26
DLR	16%	27	17
Car driver	<1%*	0	0
Car passenger	<1%*	0	0
Cycle	5%	9	6
Walk	19%	31	20
River	1%	2	1
Other (taxi/motorcycle)	4%	7	4
Total	100%	165	105

** Assumed to be zero for the purposes of the assessment*

Pedestrian routes

12.5.4 The construction phase (phase 1, phase 2 and phase 3) plans (see separate volume of figures – Section 1) show the layout of the pedestrian footways during construction.

12.5.5 A shared pedestrian and cycle footway links Norman Road (B208) to Creekside running alongside the National Rail viaduct across the creek over Ha'penny Hatch bridge. The eastern section of the footway between Norman Road (B208) and the bridge would require realignment as a result of the construction works at the Greenwich Pumping Station site. This would be necessary throughout the construction period. The realignment would be by approximately 10m to the north of the existing footway where a new shared pedestrian and cycle footway would be created.

12.5.6 To assess a busiest case scenario, it has been anticipated that all worker trips would finish their journeys by foot. As a result, the 165 and 105 worker trips generated by the site during the AM and PM peak hours respectively have been added to the construction base case pedestrian flows.

12.5.7 In determining the magnitude of impacts on pedestrian routes, the relevant impact criteria are pedestrian delay, pedestrian amenity and accidents and safety (as set out in Vol 2 Section 12).

12.5.8 With regard to pedestrian amenity, pedestrians would have to cross site access points on Greenwich High Road (A206) and Norman Road (B208) but would not be diverted from the existing footways. Furthermore, although the existing shared pedestrian and cycle footway through the site would be diverted, this would only be by 10m to the north. Taking these issues into consideration, the impact on pedestrian amenity has been assessed as being of low adverse magnitude.

12.5.9 It is anticipated that because the pedestrian routes on the north side of Greenwich High Road (A206) and the west side of Norman Road (B208) would cross the accesses to the Greenwich Pumping Station site a journey time increase of up to 30 seconds at each access point could result as a consequence of vehicle movements into and out of the site.

12.5.10 For pedestrians walking along the western footway of Norman Road (B208), five site access points to the site would need to be crossed which could lead to a journey time increase of up to 2 minutes 30 seconds. However, in practice it is highly unlikely that all site access points would be in use at the same time or that an individual pedestrian would suffer this level of delay at every access point. In the light of that, the impact on pedestrians on Norman Road (B208) would be low adverse.

12.5.11 For pedestrians walking along the northern footway of Greenwich High Road (A206), a journey time increase of less than 30 seconds is expected at the single site access point into and out of the site from Greenwich High Road (A206). This would result in a negligible impact.

12.5.12 The realignment of the existing shared pedestrian and cycle footway would result in a very small increase in journey time as the journey would be extended by less than 10m. This represents a negligible impact. Other pedestrian movements in the area would also experience a negligible impact.

12.5.13 With regard to accidents and safety, pedestrians would be required to cross site access points and the pedestrian flows would be less than 240 persons per hour. This represents a low adverse impact.

Cycle facilities and routes

12.5.14 The relevant impact criteria for determining the magnitude of impacts on cycle facilities and routes are cycle delay and accidents and safety (as set out in Vol 2 Section 12).

12.5.15 As stated in para. 12.5.5, realignment of the shared pedestrian and cycle route located to the north of the existing Greenwich Pumping Station access point from Norman Road (B208) to Creekside is anticipated throughout the duration of the construction works. This realignment is shown in Vol 24 Figure 12.5.1 (see separate volume of figures). The realignment would result in a very small increase in journey time.

12.5.16 Cyclists using Greenwich High Road (A206) and Norman Road (B208) would experience a slight delay to journey time as a result of an increase in construction traffic flow serving the site. The effect on journey times is identified in the highway operation and network assessment. Based on this information and the spare capacity available in the network it is expected that any additional delay would be a maximum of 12 seconds and therefore the impact on cyclist delay would be negligible.

12.5.17 With regard to accidents and safety, there would be an increase in construction traffic flow of greater than four two-way HGV movements per hour but less than 20 two-way HGV movements along Norman Road (B208). This represents a low adverse impact.

Bus routes and patronage

12.5.18 The relevant impact criteria when considering bus routes are road network delay and bus patronage (as set out in Vol 2 Section 12).

12.5.19 Bus routes are not anticipated to change from the base case. Additional construction vehicles serving the site may however affect bus journey times along Greenwich High Road (A206) and within the wider area. The effect on journey times is detailed in the highway operation and network assessment and would result in a maximum road network delay of 12 seconds. This represents a negligible impact.

12.5.20 It is expected that approximately 48 and 31 additional two-way worker trips would be made by bus during the AM and PM peak hours respectively, which would result in less than one worker trip per bus (based on a service of 84 buses and 86 buses within a 640m walking distance during the AM and PM peak hours respectively).

12.5.21 Based on the impact criteria outlined in Vol 2 Section 12, the additional worker trips made by bus in the peak hours would have a negligible impact on bus patronage.

DLR and National Rail and patronage

12.5.22 No DLR or rail stations are directly adjacent to the site and therefore none would be directly affected by construction works at the site. It is anticipated that approximately 68 construction workers and labourers would use DLR or National Rail services to access the site during the AM peak hour which would result in 41 additional person trips on National Rail services and 27 additional person trips on DLR services. During the PM peak hour, 26 additional person trips on National Rail services and 17 additional person trips on DLR services are anticipated.

12.5.23 On DLR services this equates to less than one person per train during the AM and PM peak hours based on a frequency of 30 trains during the peaks. On National Rail services there would be less than one additional passenger per train based on the AM peak service of 30 trains per hour and PM peak service of 28 trains per hour.

12.5.24 Based on the quantitative assessment of patronage and the impact criteria on rail patronage in Vol 2 Section 12, this would result in a negligible impact on DLR and National Rail patronage.

Parking

12.5.25 In determining the magnitude of impacts on parking, the relevant criterion are vehicle parking and loading changes (as set out in Vol 2 Section 12).

12.5.26 There would be no need to alter either car or coach parking provision as part of the construction works at the Greenwich Pumping Station site and therefore both would remain the same as in the construction base case.

12.5.27 Also, there would be no construction worker parking in the vicinity of the site as parking on surrounding streets is restricted and measures to reduce car use would be incorporated into site-specific Travel Plan requirements. Therefore there would be no impact on local parking from construction workers.

12.5.28 Based on the impact criteria outlined in Vol 2 Section 12, this represents a negligible impact on vehicle parking as there would be no change to parking facilities.

12.5.29 There would be no need to alter loading bay provision or restrictions as part of the construction works, therefore the loading bay on Greenwich High Road (A206) would remain as in the construction base case. Based on the impact criteria outlined in Vol 2 Section 12, this represents a negligible impact on loading.

Highway network and operation

12.5.30 The highway layout during construction plan (see separate volume of figures – Section 1) shows that no modification to highway or junction layouts would be required as a result of construction activity at the Greenwich Pumping Station site. The site would use existing and new access points on Greenwich High Road (A206) and Norman Road (B208). The highway layout during construction vehicle swept path analysis plan (see Greenwich Pumping Station *Transport Assessment* figures) demonstrates that the construction vehicles would be able to safely enter and leave the site.

12.5.31 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 Saturdays). However, in exceptional circumstances such as during concrete pours and to accommodate abnormal load movements, lorry movements may take place up to 22:00 on weekdays or later on agreement with the RB of Greenwich.

12.5.32 Vol 24 Table 12.5.2 shows the construction lorry movement assumptions for the local peak traffic periods. These are based on the peak months of construction activity at this site. The assessment has been based on 10% of the daily number of lorry journeys occurring in the peak hours, which has been agreed with TfL as a reasonable approach. It is recognised that it may be desirable to reduce the number of construction lorry movements in peak hours and the mechanisms for addressing this would form part of the *Traffic Management Plans* which are required as part of the *Code of Construction Practice*.

Vol 24 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 vehicle movements 10%*	154	0	15	15	0

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**
Other construction vehicle movements**	134	6	6	6	6
Worker vehicle movements***	nominal	0	0	0	0
Total	**288**	**6**	**21**	**21**	**6**

** The assessment has been based on 10% of the daily construction lorry movements associated with materials taking place in each of the peak hours.*
*** Other construction vehicle movements includes cars and light goods vehicles associated with site operations and contractor activity.*
****Worker vehicle numbers based on less than 1% of workers driving, on the basis that there would be no worker parking on site; on-street parking in the area is restricted; and site-specific Travel Plan measures would discourage workers from driving. In practical terms, this would be close to zero.*

12.5.33 To ensure a robust assessment, the assessment has been based on a combination of the peak hour movements for construction and worker vehicle movements between 07:00-09:00 and 18:00-19:00. These have been combined and applied to the peak hour to take into account the highest number of movements generated by the site.

12.5.34 Based on all materials being transported by road, an average peak flow of 288 vehicle movements a day is expected during the months of greatest activity during Site Year 3 of construction at this site. At other times in the construction period, vehicle flows would be lower than this average peak figure.

12.5.35 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 Vol 2 Section 12).

12.5.36 It is anticipated that along Greenwich High Road (A206) and Norman Road (B208) there would be an additional 15 two-way HGV movements per hour as a result of the construction at Greenwich Pumping Station. As the site accesses are not directly onto the TLRN, this results in a low adverse impact in relation to accidents and safety.

12.5.37 It is estimated that there may be approximately two hazardous load vehicles per week at this site. On that basis, there would be a medium adverse impact in relation to the number of hazardous loads generated by the site.

12.5.38 The local LinSig model has been used to apply the construction traffic demands to the construction base case to determine the changes in the highway network operation due to the project (ie, comparison of base and development cases). The traffic flows for the development case (providing input to the LinSig model) are shown on Vol 24 Figure 12.4.6 and Vol 24 Figure 12.4.7 (see separate volume of figures).

12.5.39 A summary of the construction assessment results for the weekday AM and PM peak hours is presented in Vol 24 Table 12.5.3 and Vol 24 Table 12.5.4. The construction base case model indicates that the local highway will be operating within capacity without the Thames Tideway Tunnel project proposals.

12.5.40 The construction traffic generated by the Thames Tideway Tunnel project would produce a marginal increase in demand resulting in a slight increase to delay on this part of the network with the maximum increase on Greenwich High Road (A206) (eastbound - right turn) of eight seconds delay per vehicle during the AM peak hour and a 12 seconds delay per vehicle during the PM peak hour.

12.5.41 The results indicate that the project would result in a slight reduction in capacity along Greenwich High Road (A206) and Norman Road (B208). However, overall the junction would continue to operate within capacity. This would result in a negligible impact, based on the impact criteria identified in Vol 2 Section 12.

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Vol 24 Table 12.5.3 Transport – construction LinSig model outputs (AM peak hour)

Approach	Arm	Flow (PCUs)	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
Greenwich High Road (A206) east	Ahead	235	22%	23%	+1%	2	2	0	9	9	0
	Right	3	0%	0%	+0%	0	0	0	0	8	+8
Greenwich High Road (A206) west	Ahead / left	293	32%	36%	+4%	3	4	+1	14	15	+1
Norman Road (B208) southbound	Right / left	132	33%	36%	+3%	2	2	0	29	28	-1
			PRC						Total delay (PCU hours)		
Overall junction performance			174.2%	149.8%	-24.4%				2.73	3.09	+0.36

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 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 2.3 PCUs. Buses and coaches are two PCUs. Motorcycles are 0.4 PCUs and pedal cycles are 0.2 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. 12.3.22.

Vol 24 Table 12.5.4 Transport – construction LinSig model outputs (PM peak hour)

Approach	Arm	Flow (PCUs)	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
Greenwich High Road (A206) east	Ahead	184	23%	24%	+1%	2	2	0	14	15	0
	Right	3	0%	0%	0%	0	0	0	0	14	+12
Greenwich High Road (A206) west	Ahead / left	362	60%	67%	+4%	6	6	0	26	29	+3
Norman Road (B208) southbound	Right / left	397	63%	64%	+1%	6	6	0	25	24	-1
			PRC						Total delay (PCU hours)		
Overall junction performance			42%	35%	-7%				7.03	7.63	+0.6

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 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 2.3 PCUs. Buses and coaches are two PCUs. Motorcycles are 0.4 PCUs and pedal cycles are 0.2 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. 12.3.22.

Significance of effects

12.5.42 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 24 Table 12.4.2 and Vol 24 Table 12.4.3.

12.5.43 Vol 24 Table 12.5.5 sets out the effects on each receptor in the vicinity of the site.

Vol 24 Table 12.5.5 Transport – significance of effects during construction

Receptors (relating to all identified transport effects)	Significance of effect	Justification (receptor sensitivity and impacts)
Pedestrians and cyclists (including sensitive pedestrians) on Greenwich High Road (A206) and Norman Road (B208)	Minor adverse effect on pedestrians Minor adverse effect on cyclists	**Pedestrians:** • High sensitivity • Low adverse impact on pedestrian delay, pedestrian amenity and accidents and safety • Due to all impacts of low adverse magnitude, equates to minor adverse effect **Cyclists:** • High sensitivity • Negligible impact on cycle delay • Low adverse impact on accidents and safety • Due to negligible and low adverse impact magnitudes, and the sensitivity of the receptor, this equates to a minor 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 • Low adverse impact

Receptors (relating to all identified transport effects)	Significance of effect	Justification (receptor sensitivity and impacts)
		on accidents and safety • Medium adverse impact from hazardous loads • Due to negligible, low and medium adverse impact magnitudes, and the sensitivity of the receptor, this equates to a minor adverse effect **Parking users:** • Medium sensitivity • Negligible impact on on-street parking • Due to negligible magnitude, equates to negligible effect
Emergency vehicles travelling on Greenwich High Road (A206) and Norman Road (B208)	Minor adverse effect	• High sensitivity • Negligible impact on road network delay • Low adverse impact on accidents and safety • Medium adverse impact from hazardous loads • Due to negligible, low and high adverse impact magnitudes, and the sensitivity of the receptor, this equates to a minor adverse effect
Service vehicles using loading bay along Greenwich High Road (A206)	Negligible effect	• Low sensitivity • Negligible impact on loading bay • Due to negligible impact, equates to

Receptors (relating to all identified transport effects)	Significance of effect	Justification (receptor sensitivity and impacts)
		negligible effect
Bus users (passengers) travelling along Greenwich High Road (A206)	Negligible effect	• Medium sensitivity • Negligible impact on road network delay and patronage • Due to negligible impacts, equates to negligible effect
Public transport users using DLR or rail services within the area	Negligible effect	• Low sensitivity • Negligible impact on patronage • Due to negligible impact, equates to negligible effect
Patrons of public house Residents of43-81 Greenwich High Road (A206) Residents of 83-87 Greenwich High Road (A206) Residents and users of Hilton's Wharf Residents and users of Greenwich Industrial Estate	Minor adverse effect on pedestrians Minor adverse effect on cyclists Minor adverse effect on highway users Negligible effect on parking users	**Pedestrians:** • High sensitivity • Low adverse impact on pedestrian delay, pedestrian amenity and accidents and safety • Due to all impacts of low adverse magnitude, equates to minor adverse effect **Cyclists:** • High sensitivity • Negligible impact on cycle delay • Low adverse impact on accidents and safety • Due to negligible and low adverse impact magnitudes, and the sensitivity of the receptor, this equates to a minor adverse

Receptors (relating to all identified transport effects)	Significance of effect	Justification (receptor sensitivity and impacts)
		effect **Highway users:** • High sensitivity • Negligible impact on road network delay • Low adverse impact on accidents and safety • Medium adverse impact from hazardous loads • Due to negligible, low and high adverse impact magnitudes, and the sensitivity of the receptor, this equates to a minor adverse effect **Parking users:** • High sensitivity • Negligible impact on on-street parking • Due to negligible magnitude, equates to negligible effect
Visitors and staff at newsagents Users of Greenwich West Community and Arts Centre Users of Devonshire Drive Baptist Church	Minor adverse effect on pedestrians Minor adverse effect on cyclists Minor adverse effect on highway users Negligible effect on parking users	**Pedestrians:** • Medium sensitivity • Low adverse impact on pedestrian delay, pedestrian amenity and accidents and safety • Due to all impacts of low adverse magnitude, equates to minor adverse effect **Cyclists:** • Medium sensitivity • Negligible impact on cycle delay

Receptors (relating to all identified transport effects)	Significance of effect	Justification (receptor sensitivity and impacts)
		• Low adverse impact on accidents and safety • Due to negligible and low adverse impact magnitudes, and the sensitivity of the receptor, this equates to a minor adverse effect **Highway users:** • Medium sensitivity • Negligible impact on road network delay • Low adverse impact on accidents and safety • Medium adverse impact from hazardous loads • Due to negligible, low and high adverse impact magnitudes, and the sensitivity of the receptor, this equates to a minor adverse effect **Parking users:** • Medium sensitivity • Negligible impact on on-street parking • Due to negligible magnitude, equates to negligible effect
Students and staff at Lewisham College (Deptford campus)	Negligible effect on pedestrians Negligible effect on cyclists Minor adverse effect on highway users	**Pedestrians:** • Low sensitivity • Low adverse impact on pedestrian delay, pedestrian amenity and accidents and safety

Receptors (relating to all identified transport effects)	Significance of effect	Justification (receptor sensitivity and impacts)
		• Given the sensitivity of the receptor, equates to a negligible effect. **Cyclists:** • Negligible impact on cycle delay • Low adverse impact on accidents and safety • Given the sensitivity of the receptor, equates to a negligible effect. **Highway users:** • Low sensitivity • Negligible impact on road network delay • Low adverse impact on accidents and safety • Medium adverse impact from hazardous loads • Equates to a minor adverse effect.

Sensitivity test for programme delay

12.5.44 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.

12.5.45 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

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 and rail 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 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 Greenwich Pumping Station 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

d. Based on the site development schedule (see Vol 24 Appendix N), it is possible that as a result of a one year delay, the Creekside Village East development which has been assumed to be under construction in this assessment would be partially complete and occupied. However, it is not expected that new receptors would experience any different effects to those receptors which have been assessed above; rather it would be a case of the potential for some additional receptors to experience the same effects that have already been identified.

12.6 Operational effects assessment

12.6.1 This section summarises the findings of the assessment undertaken for Year 1 of operation at the Greenwich Pumping Station site.

12.6.2 The transport demands created by the development in the operational phase would be extremely low and limited to occasional maintenance visits every three to six months, and larger cranes and associated support vehicles required for access to the shaft and tunnel approximately every ten years.

12.6.3 The assessment of the operational phase has therefore limited to the physical issues associated with accessing the site from the highway network as outlined in Section 12.2. This has been agreed with the RB of Greenwich and TfL.

12.6.4 The operational assessment has taken into consideration those elements that would be affected, which comprise the short-term impacts on the highway layout and operation when maintenance visits are made to the site.

Highway layout and operation

12.6.5 During the operational phase, the site would be served from the existing access point that serves the existing Thames Water facility on Norman Road (B208). The permanent highway layout plan (see separate volume of figures – Section 1) shows the access arrangements for the operational phase.

12.6.6 For routine three or six monthly inspections vehicular access would be required for light commercial vehicles, typically a transit van. On occasion there may be a need for flatbed vehicles to access the site.

12.6.7 During ten-yearly inspections, space to locate two large cranes 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. To assess the effect of these on the highway layout, swept paths have been undertaken for the largest vehicles including 11.36m mobile cranes, a 10m articulated vehicle and a 10.7m articulated vehicle. The permanent highway layout vehicle swept path analysis plan (see Greenwich Pumping Station *Transport Assessment* figures) demonstrates that maintenance vehicles would be able to safely enter and leave the site.

12.6.8 When larger vehicles are required to serve the site, there may also 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.

12.6.9 In accordance with the criteria outlined in Vol 2 Section 12, during the routine inspections of the operational site, there would be a negligible impact on road network delay.

12.6.10 Taking into consideration the various sensitivities of the receptors affected during the operational phase (private vehicle users and emergency vehicles) as identified in Vol 24 Table 12.4.2, this would result in a **negligible** effect on highway layout and operation.

Sensitivity test for programme delay

12.6.11 If the opening year of the Thames Tideway Tunnel project 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 24 Appendix N), all of the other developments identified within 1km of the Greenwich Pumping Station site would be complete and operational by Site Year 3 of construction with the exception of the Creekside Village East development and Heathside and Lethbridge Estate redevelopment. However there are no specific cumulative effects to assess as 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 (TfL, 2011)[6]. 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. 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 detailed in para. 12.3.16, the Heathside and Lethbridge Estate development would be under construction in Year 1 of operation at the Greenwich Pumping Station site. This suggests that there are cumulative effects to assess for the operational assessment. However, given the distance of the development from the site, cumulative effects would not be significant.

12.7.4 The effects therefore remain as described in Section 12.6. This would also be the case if the programme for the Thames Tideway Tunnel project were delayed by approximately one year.

12.8 Mitigation

12.8.1 The project has been designed to limit the effects on transport networks as far as possible and many measures have been embedded directly in the design of the project including the *CoCP* and *Draft Project Framework Travel Plan*. No additional measures are proposed for transport and therefore there is no mitigation identified for either construction or operation.

12.9 Residual effects assessment

Construction effects

12.9.1 As no mitigation measures are proposed, the residual construction effects remain as described in Section 12.5. All residual effects are presented in Section 12.10.

Operational effects

12.9.2 As no mitigation measures are proposed, the residual operational effects remain as described in Section 12.6. All residual effects are presented in Section 12.10.

12.10 Assessment summary

Vol 24 Table 12.10.1 Transport – summary of construction assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Pedestrians and cyclists (including sensitive pedestrians) on Greenwich High Road (A206) and Norman Road (B208)	• Realignment of pedestrian and cycling route • Increased journey time for pedestrians and cyclists • Movement of large construction vehicles	Minor adverse effect on pedestrians Minor adverse effect on cyclists	None	Minor adverse effect on pedestrians Minor adverse effect on cyclists
Private vehicle users in the area using the local highways or on-street parking bays	• Delay to journey time • Movement of large construction vehicles	Minor adverse effect on highway users Negligible effect on parking users	None	Minor adverse effect on highway users Negligible effect on parking users
Emergency vehicles travelling on Greenwich High Road (A206) and Norman Road (B208)	• Delay to journey time • Movement of large construction vehicles	Minor adverse effect	None	Minor adverse effect
Service vehicles using loading bay on Greenwich High Road (A206)	• No effect on loading bay	Negligible effect	None	Negligible effect
Bus users (passengers) travelling along	• Delay to journey time • Movement of large	Negligible effect	None	Negligible effect

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Greenwich High Road (A206) and Norman Road (B208)	construction vehicles • Some additional patronage from construction workers			
Public transport users using DLR or rail services within the area	• Some additional patronage from construction workers	Negligible effect	None	Negligible effect
Patrons of public house Residents of 43-81 Greenwich High Road (A206) Residents and users of 83-87 Greenwich High Road (A206) Residents and users of Hilton's Wharf Residents and users of Greenwich Industrial Estate	• Realignment of pedestrian and cycling route • Delay to journey time • Movement of large construction vehicles	Minor adverse effect on pedestrians Minor adverse effect on cyclists Minor adverse effect on highway users Negligible effect on parking users	None	Minor adverse effect on pedestrians Minor adverse effect on cyclists Minor adverse effect on highway users Negligible effect on parking users
Visitors and staff at newsagents Users of Greenwich West Community and Arts Centre Users of Devonshire	• Realignment of pedestrian and cycling route • Delay to journey time • Movement of large construction vehicles	Minor adverse effect on pedestrians Minor adverse effect on cyclists Minor adverse effect on highway users	None	Minor adverse effect on pedestrians Minor adverse effect on cyclists Minor adverse effect on highway users

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Drive Baptist Church		Negligible effect on parking users		Negligible effect on parking users
Students and staff at Lewisham College (Deptford campus)	• Delay to journey time • Movement of large construction vehicles	Negligible effect on pedestrians Negligible effect on cyclists Minor adverse effect on highway users	None	Negligible effect on pedestrians Negligible effect on cyclists Minor adverse effect on highway users

Vol 24 Table 12.10.2 Transport – summary of operational assessment

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Private vehicle users in the area using the local highways	• Occasional maintenance trips resulting in some temporary, short-term road network delay	Negligible effect	None	Negligible effect
Emergency vehicles travelling on Greenwich High Road (A206) and Norman Road (B208)	• Occasional maintenance trips resulting in some temporary, short-term road network delay	Negligible effect	None	Negligible effect

References

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

[2] TfL, *Travel Planning for new development in London*, Transport for London (2011).

[3] Transport for London, Assessment Tool for Travel plan Building Testing and Evaluation (ATTrBuTE) (2011) 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] Transport for London, 2011. 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: **6.2.24**

Volume 24: Greenwich Pumping Station site assessment

Section 13: Water resources - groundwater

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 24: Greenwich Pumping Station 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 Greenwich Pumping Station site.

13.1.2 The proposed development has the potential to affect groundwater due to:

a. dewatering of aquifer units

b. use of grout/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 combined sewer overflow (CSO) drop shaft during operations.

13.1.3 This groundwater assessment at this site should be read in conjunction with the supporting Vol 24 Appendix K (K.1 – K.9) and the land quality assessment (see Section 8 Land quality).

13.1.4 The site is underlain by a secondary A aquifer[i] (the upper aquifer) and a principal aquifer [ii] (the lower aquifer), which are likely to be in hydraulic continuity where the London Clay Formation and Lambeth Group are absent (in the northern part of site). The Greenwich Pumping Station site lies within a Source Protection Zone (SPZ) [iii] of a Chalk public water supply source located within 1km of the site. There are two other licensed groundwater abstractions for Ground Source Heat Pumps (GSHP) in the lower aquifer within 1km of the site.

13.1.5 Dewatering would be required at this site, but it would be internal to the diaphragm walls[iv].

13.1.6 An assessment of project-wide environmental effects on groundwater is presented in Volume 3 Project-wide assessment.

13.1.7 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

[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] Source Protection Zones – are defined around all major public water supply abstractions sources and large licensed private abstractions in order to safeguard groundwater resources from potentially polluting activities

[iv] 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

environment including groundwater resources and quality are presented and the anticipated effects (including cumulative effects) on these resources addressed in the assessment that follows (further detail can be found in Vol. 2 Section 13.3).

13.1.8 Plans of the proposed development as well as figures included in the assessment for this site are contained in a separate volume (Volume 24 Greenwich Pumping Station 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 Greenwich Pumping Station site, relevant to the consideration of groundwater, would include:

a. A CSO drop shaft of approximately 17m internal diameter (ID) and approximately 46m deep (based on 58.64mATD[v] from an assumed shaft cover slab surface level of 104.5mATD), excluding a 3m thick base slab once constructed, constructed in the northern part of the Greenwich Pumping Station site.

b. An interception chamber for the existing CSO and other near ground structures for ventilation and controls.

c. A connection culvert from the interception chamber to the CSO drop shaft.

13.2.3 The proposed methods of construction for these elements of the Greenwich Pumping Station site are described in Section 3 proposed development of this volume and summarised in Vol 24 Table 13.2.1. Approximate duration of construction and depths are also contained in Vol 24 Table 13.2.1.

Vol 24 Table 13.2.1 Groundwater – methods of construction

Design element	Method of construction	Construction periods (years)*	Construction depth(mbgl)**
CSO drop shaft	Diaphragm walls with internal dewatering	1	Deep (around 46)
Tunnel launch	Break out of drop	<1	Deep

[v] In general, the measurements of depth are expressed as metres Above Tunnel Datum (mATD). The standard zero point for mATD scale is -100maOD (metres above Ordnance Datum is based on Newlyn datum point for mean sea level). The use of the mATD scale avoids the need for use of negative values, and is widely used for large scale sub-surface projects

Design element	Method of construction	Construction periods (years)*	Construction depth(mbgl)**
	shaft by TBM		
Interception chamber and connection culvert	Secant piling[vi] with local dewatering and ground treatment	<1	Deep (around 11)

** The site would be used for construction purposes for up to five and a half years*
*** In terms of construction depth - Shallow (<10m) and Deep (>=10m).*

Code of Construction Practice

13.2.4 All works would be undertaken in accordance with the *Code of Construction Practice (CoCP)*. The *CoCP* is provided in Vol 1 Appendix A. It contains general requirements *(Part A)*, and site specific requirements for this site *(Part B)*. Relevant measures included within the *CoCP (Part A)* 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 (EA) guidelines (EA, 2011)[2]. The contractor would have plans and equipment in place to deal with emergency situations as well as ensuring that staff are appropriately trained.

b. A precautionary approach, involving targeted risk-based audits and checks by monitoring of water quality, would be applied to licensed abstractions thought to be at risk.

c. Monitoring arrangements for dewatering permits and any permits required on change of licensing regulations would be developed in liaison with the EA (see also the groundwater monitoring strategy in Vol 3 Appendix K.1).

d. The use of any materials for ground treatment would be agreed with the EA prior to use.

e. At the end of construction where temporary support does not form part of the operational structure it would be removed, piped through or cut 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 Part B*.

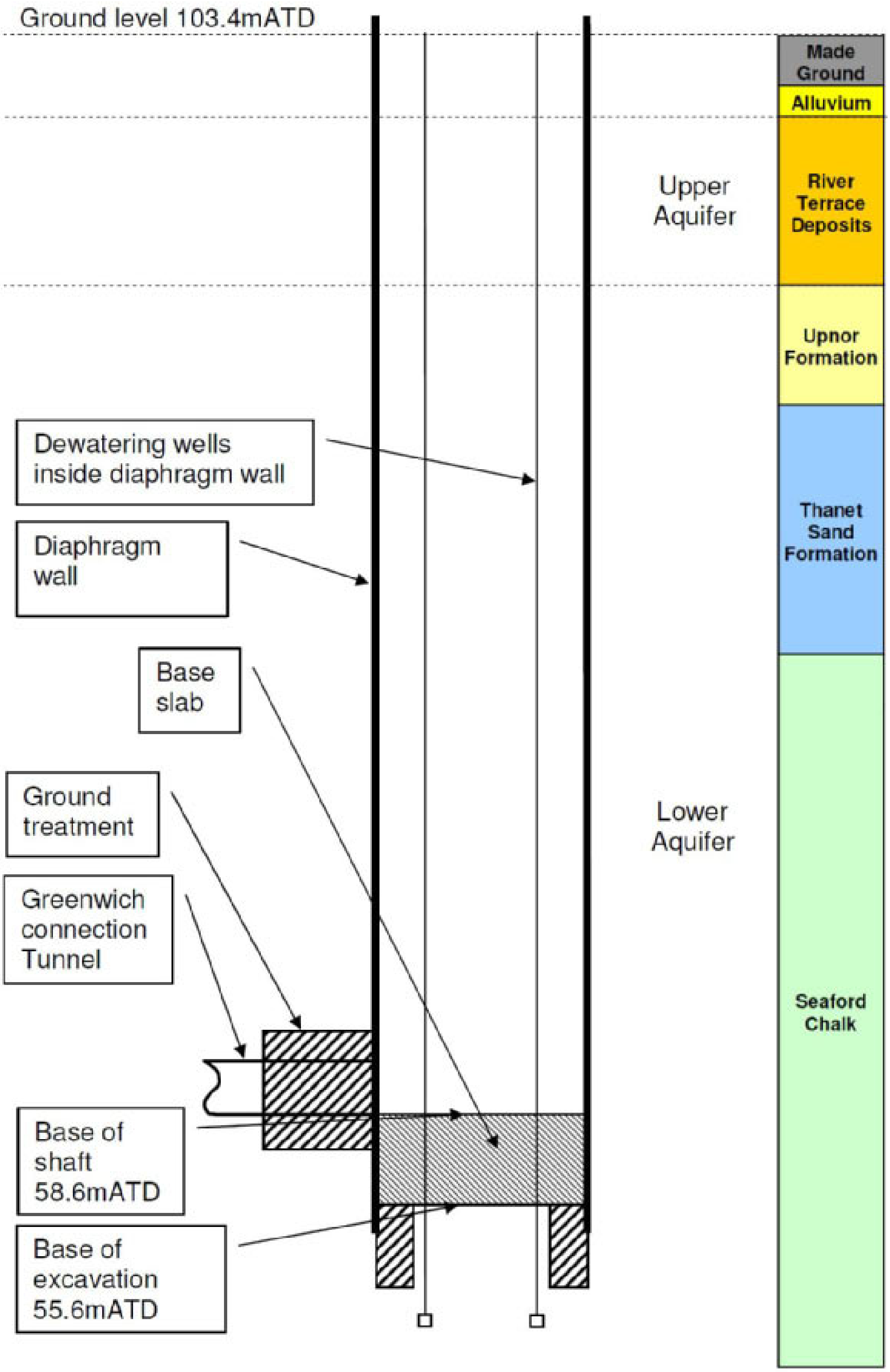
Other measures during construction

13.2.6 The depth of the CSO drop shaft means that it would extend into the Seaford Chalk (and approximately 34m into the lower aquifer) (see Vol 24

[vi] Secant piling - a sub-surface structure installed to support excavation and which amongst other things helps to control inflows of shallow groundwater typically formed of intersecting concrete or overlapping shafts of concrete.

Table 13.4.1 and Vol 24 Appendix K.1), which is expected to contain substantial quantities of groundwater. The CSO drop shaft would be constructed using diaphragm walling techniques (see Vol 24 Plate 13.2.1) installed to a depth suitable to reduce the flow of water into the drop shaft, to below the base of the drop shaft. This would reduce the amount of pumping required from within the diaphragm wall. There would be no pumping external to the diaphragm wall (internal dewatering would be undertaken). This approach should ensure any movement of known groundwater contamination beneath the site (see Section 13.4) is minimised during pumping. Pumping would be required during construction of the drop shaft for approximately 12 months and for the break out of the drop shaft for the tunnel boring machine (TBM) into the Greenwich connection tunnel for approximately 6 months.

Vol 24 Plate 13.2.1 Groundwater – schematic of a diaphragm wall with internal dewatering



Not to scale
For illustrative purposes only

13.2.7 The water levels outside the diaphragm wall would be drawn down by only a few centimetres, due to the barrier effects. An estimate of the amount of dewatering needed at the Greenwich Pumping Station site is less than $200m^3/d$. This relatively small volume is due to the method proposed to construct the CSO drop shaft. The pumped groundwater would be discharged directly to Deptford Creek, following any necessary treatment and subject to EA approval.

13.2.8 The depth of the interception chamber and connection culvert means that they would extend into the Lambeth Group (see Vol 24 Table 13.4.1 and Vol 24 Appendix K.1), which is expected to be water-bearing in places. The River Terrace Deposits overlying the Lambeth Group would also be expected to be water bearing. These sub-surface structures would be constructed using secant piling and localised dewatering within the River Terrace Deposits and the Lambeth Group (within 0.4m of the base of excavation) would be required. Dewatering wells would be drilled around the inside periphery of the secant piling and pumps would be placed in the wells to lower the pressure. Groundwater would be extracted and following any necessary treatment and subject to EA approval, discharged directly into Deptford Creek. The duration of pumping would be determined by ground conditions but could be for the duration of the interception works.

13.2.9 Ground treatment, including fissure grouting[vii] below the toe of the diaphragm walls, is anticipated to be required in the Chalk (lower aquifer) for drop shaft construction and to facilitate TBM break out. It is also anticipated that some grouting would be required in the River Terrace Deposits and Lambeth Group for the construction of the interception chamber works where the excavation spans the existing sewer. This ground treatment is likely to be permeation grouting and jet grouting. For the purposes of this assessment, no other ground treatment is anticipated to be required.

Operation

13.2.10 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 Vol 2 Section 13.2 documents the overall engagement which has been undertaken in preparing the *Environmental Statement*. There have been no site specific comments relevant to the Greenwich Pumping Station site for the assessment of groundwater.

[vii] Grouting - a thin, coarse mortar injected into various narrow cavities or voids , such as rock fissures, to fill them and consolidate the adjoining objects into a solid mass and to eliminate water.

Baseline

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

13.3.3 The baseline describes receptors within a 1km radius of the site 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 of wider regional significance and are assessed in the project-wide assessment (see Vol 3 Section 10).

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 1 of construction, when dewatering would first take place within the diaphragm wall. The baseline is not anticipated to change substantially between 2011 and Site Year 1 of construction (2016) 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 included in Vol 24 Table 13.3.1. The developments relevant to groundwater are those which would contain basements.

Vol 24 Table 13.3.1 Groundwater – construction base case and cumulative assessment developments (2016)

Development	Component or receptor relevant to groundwater	Construction base case	Cumulative effect assessment
83-87 Greenwich High Road	Basement*	✓	✗
Greenwich Industrial Estate - land bounded by Norman Road, Greenwich High Road and Waller Way, Greenwich	Basement*	✓	✗
Hilton's Wharf, 30 - 52 Norman Road	Basement*	✓	✗

Development	Component or receptor relevant to groundwater	Construction base case	Cumulative effect assessment
Site of old Seagar Distillery and Norfolk House	Basement*	✓	×
Heathside and Lethbridge Estate	Basement*	✓	×
Land at Stockwell Street and John Humphries House	Basement*	✓	×
Greenwich Reach East	Basement*	✓	×
Bardsley Lane - Land at Creek Road/ Bardsley Lane	Basement*	✓	×
Block E, 43-81 Greenwich High Road	Basement*	✓	×
Creekside Village East (Thanet Wharf), Copperas Street	Basement*	×	✓
Land opposite North Greenwich Pier, Greenwich Peninsula, Greenwich.	None	×	×

** Relevant to the upper aquifer*
Symbols ✓ applies × does not apply

13.3.9 Section 13.5 details the likely significant effects arising from the construction at the Greenwich Pumping Station 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 within the assessment area for this site. These Thames Tideway Tunnel project sites are therefore included in the assessment of the impact of dewatering on the lower aquifer and licensed abstractions at the Greenwich Pumping Station, following the methodology set out in Vol 2 Section 13.

Operation

13.3.10 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.

13.3.11 The assessment year applied to the operational assessment is Year 1 of operation. The baseline is not anticipated to vary significantly by the start of the operational phase in 2023; and therefore baseline data from 2011 have formed the basis for the operational assessment. In addition, information on proposed development schemes likely to have been completed before commencement of the operation of the Thames Tideway Tunnel has formed part of the operational base case.

13.3.12 The developments considered as part of the operational base case are included in Vol 24 Table 13.3.2. No developments have been identified which would be considered as part of the cumulative effects assessment. The developments relevant to groundwater are those which would contain basements.

Vol 24 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
83-87 Greenwich High Road	Basement*	✓	✗
Greenwich Industrial Estate - land bounded by Norman Road, Greenwich High Road and Waller Way, Greenwich	Basement*	✓	✗
Hilton's Wharf, 30 - 52 Norman Road	Basement*	✓	✗
Site of old Seagar Distillery and Norfolk House	Basement*	✓	✗
Heathside and Lethbridge Estate	Basement*	✓	✗
Land at Stockwell Street and John Humphries House	Basement*	✓	✗
Greenwich Reach East	Basement*	✓	✗
Bardsley Lane - Land at Creek Road/ Bardsley Lane	Basement*	✓	✗
Block E, 43-81 Greenwich High Road	Basement*	✓	✗
Creekside Village East (Thanet Wharf), Copperas Street	Basement*	✓	✗
Land opposite North Greenwich Pier, Greenwich Peninsula, Greenwich.	None	✗	✗

** Relevant to the upper aquifer*
Symbols ✓ applies ✗ does not apply

13.3.13 Section 13.6 details the likely significant effects arising from the operation at the Greenwich Pumping Station 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 the Greenwich Pumping Station 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 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 (see Vol 2 Section 13). The hydraulic properties for the Chalk obtained from this model include an average transmissivity value of approximately 2,000m^2/d (EA and ESI, 2010)[3] and a storativity[viii] value of approximately 1 x10^{-4} at the Greenwich site (see Vol 2 Section 13).

13.3.16 The anticipated amount of pumping required from within the diaphragm wall at the Greenwich Pumping Station site is assumed to be less than 200m^3/d.

13.3.17 The assessment of obstruction effects in Sections 13.5 and 13.6 is based on estimated hydraulic gradient[ix] of 0.004 in the upper aquifer across the site.

13.3.18 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, 2011)[4] and this indicates flow towards the northwest. However, the site lies within the capture zone for a major public water supply source located to the south, which is likely to reverse the regional groundwater flow direction here towards the southeast. Given that the upper and lower aquifers are likely to be in hydraulic continuity, it is also likely that the direction of groundwater movement in both these aquifers would be similar.

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 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

13.3.22 For the purposes of this assessment, deep refers to greater than 10m below ground level (bgl) and shallow refers to less than 10m bgl.

[viii] Storativity – the volume of water released for a unit change in water level (in a confined aquifer)

[ix] Hydraulic gradient – the slope of the water table which drives groundwater movement

Limitations

13.3.23 No site-specific pumping tests have yet been undertaken as part of the ground investigation. In the absence of site-specific hydrogeological data, published sources of hydrogeological information have been used in this assessment (see Vol 24 Appendix K).

13.3.24 Groundwater level available for this assessment is limited, with monitoring data available from two monitoring boreholes within the upper aquifer. This has meant that hydraulic gradients have only been 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 within the upper aquifer might occur.

13.3.25 Despite the limitations identified above, the assessment which uses the best available information is considered robust.

13.4 Baseline conditions

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

13.4.2 This section of the assessment is supported by Vol 24 Appendix K1 – K.9.

Current baseline

Hydrogeology

13.4.3 The depth of the CSO drop shaft would pass through Made Ground, River Terrace Deposits, Lambeth Group (absent in places), Thanet Sands and Seaford Chalk. The superficial and solid geology in the vicinity of the site, as published by the British Geological Survey (BGS)[5], is shown in Vol 24 Figure 13.4.1 and Vol 24 Figure 13.4.2 respectively (see separate volume of figures).

13.4.4 The River Terrace Deposits form the upper aquifer and are classified by the EA as a secondary A aquifer[x]. The Upnor Formation, Thanet Sands and Chalk form the lower aquifer and are classified by the EA as a principal aquifer. The thickness of the Lambeth Group varies considerably over short distances and is either absent or up to 5m thick. There is expected to be hydraulic continuity between the upper and lower aquifers at the Greenwich Pumping Station site.

13.4.5 The depths and thicknesses of the geological layers have been determined by reference to three ground investigation boreholes located within 68m from the Greenwich Pumping Station CSO drop shaft site: SR1018D, PR1023 and SR1024. The locations of these boreholes around the site are shown in Vol 24 Figure 13.4.3 (see separate volume of

[x] 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).

figures). The depths and thicknesses of geological layers encountered are summarised in Vol 24 Table 13.4.1.

Vol 24 Table 13.4.1 Groundwater – anticipated ground conditions/ hydrogeology

Formation	Top elevation* (mATD)	Depth below ground level (m)	Thickness (m)	Hydrogeology
Made Ground	103.36	0.00	2.10	Hydraulic continuity with upper aquifer**
Alluvium	101.26	2.10	1.30	
River Terrace Deposits	99.96	3.40	7.00	Upper aquifer
Lambeth Group (Upnor Formation)****	92.96	10.40	5.00	Lower aquifer
Thanet Sand	87.96	15.40	10.40	
Seaford Chalk ****	77.56	25.80	Not proven	

** Based on an assumed ground level of 103.36mATD*
***It has been assumed that the made ground and alluvium are in hydraulic connectivity for the purposes of this assessment.*
**** At two other on site boreholes SA4086 and SR4087 (situated to the north of the CSO drop shaft site) no Lambeth Group was encountered. This is consistent with published geological map of the area.*
***** SR4087 has proven the Seaford Chalk to be 48.3m at this location.*

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 network of observation monitoring boreholes across London for which records are available dating back over 50 years.

13.4.7 The information on groundwater levels for this assessment was collected from three ground investigation boreholes located within 68m of the Greenwich CSO drop shaft site (PR1023, SR1018D and SR1024). These boreholes have response zones[xi] in the River Terrace Deposits, Thanet Sand and Seaford Chalk and are monitoring groundwater levels in both the upper and lower aquifers. The locations are shown in Vol 24 Figure 13.4.3 (see separate volume of figures). Vol 24 Table 13.4.2 summarises the minimum, average and maximum water levels at the three ground investigation boreholes. Further detail on water level monitoring is provided in Vol 24 Appendix K.3.

[xi] Response zone - the section of a borehole that is open to the host strata (EA, 2006)

Vol 24 Table 13.4.2 Groundwater – recorded water levels

Monitoring borehole ID	Formation	Average over the period of record (mATD)	Minimum (mATD)	Maximum (mATD)
PR1023 (U)	River Terrace Deposits	97.48	96.98	97.77
PR1023 (L)	Thanet Sands	97.54	96.99	97.93
SR1018D	Thanet Sands	97.50	97.03	97.78
SR1024	Seaford Chalk	98.54	97.98	99.39
TQ37/254A	Seaford Chalk	97.70	96.74	98.91

13.4.8 The recorded water levels in the River Terrace Deposits at PR1023 remain below the top of the formation, indicating that the River Terrace Deposits are unconfined and not fully saturated at this location. For the purposes of this assessment, it is assumed that the upper aquifer is in hydraulic continuity with the overlying layers, Alluvium and Made Ground.

13.4.9 The water levels (piezometric head[xii]) in the Thanet Sands are monitored at two locations. The recorded water levels at SR1018D and PR1023 are very similar and remain above the top of the formation, indicating that the Thanet Sands are fully saturated at this location. The recorded water levels are also very similar to recorded water levels in the River Terrace Deposits at PR1023. This suggests that these units are in hydraulic continuity.

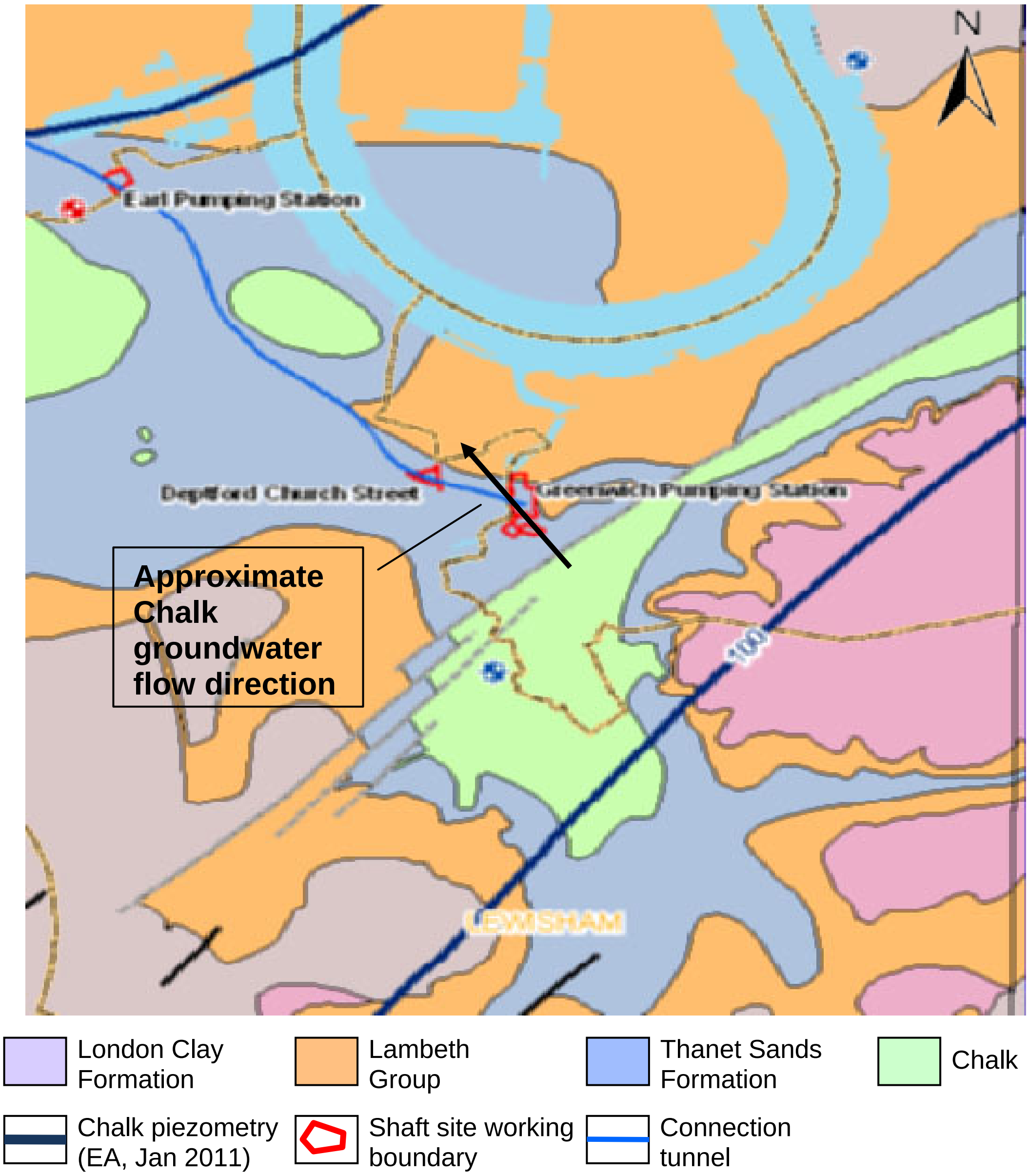
13.4.10 The nearest EA groundwater level monitoring boreholes are located within 10m of the Greenwich Pumping Station site, reference numbers TQ37/254A, TQ37/254BL and TQ37/254BU. These boreholes record levels in the lower aquifer (mainly Chalk) and the locations are shown on Vol 24 Figure13.4.4 (see separate volume of figures). These three boreholes show very similar water levels and the manual dip and logger data collected from TQ37/254A only is shown in Vol 24 Table 13.4.2 Groundwater – recorded water levels above. The recorded water levels here are approximately similar to levels recorded in the River Terrace Deposits and Thanet Sands at PR1023 and in the Chalk at SR1024, suggesting that these units are in hydraulic continuity.

13.4.11 The EA produces an annual groundwater contour map of the Chalk piezometric levels showing a snap-shot of groundwater flows in time (EA, 2011b). The January 2011 map indicates that the regional direction of groundwater flow (perpendicular to groundwater contours) at this point in time was northwest in the Chalk around Greenwich (see Vol 24 Plate 13.4.1). However the site lies within the capture zone for a major public

[xii] Piezometric head – the level or pressure head to which confined groundwater would rise to in a piezometer if it is open to the atmosphere.

water supply source located to the south, which is likely to reverse the regional groundwater flow direction here to towards the southeast. As the River Terrace Deposits, the Thanet Sands and the Seaford Chalk appear to be in hydraulic continuity, the groundwater flow direction in the River Terrace Deposits is also likely to be in a south-easterly direction in this area.

Vol 24 Plate 13.4.1 Groundwater – Chalk water level contour map



**Extract from Vol 24 Figure 13.4.2 (see separate volume of figures)*

Licensed abstractions

13.4.12 There are no licensed groundwater abstractions from the River Terrace Deposits or upper aquifer within 1km of the Greenwich Pumping Station site. However there are three licensed groundwater abstractions from the Chalk or lower aquifer and these are described below.

13.4.13 A licensed abstraction (28/39/43/0019) is located with a kilometre to the south of the Greenwich site and is held by Thames Water Utilities Limited.

The groundwater is abstracted from six boreholes and is used for public supply purposes.

13.4.14 Two further licensed abstractions (TH/39/44/0003 and TH/39/44/0006) are located 0.9km to the east-northeast of the Greenwich site and are held by the Trustees of National Maritime Museum. There are two abstractions points and two discharge points used for an open loop Ground Source Heat Pump (GSHP) scheme.

13.4.15 There are no known unlicensed groundwater abstractions within a 1km radius of the Greenwich Pumping Station site.

13.4.16 There is an old well situated within Greenwich Pumping Station site which is no longer in use. This well close by the interception chamber and would be demolished/back-filled as part of the construction phase. Further details on this well are included in Vol 24 Appendix K.4.

Groundwater source protection zones

13.4.17 The EA defines SPZ around all major public water supply abstractions sources and large licensed private abstractions in order to safeguard groundwater resources from potentially polluting activities.

13.4.18 The Greenwich Pumping Station site straddles a modelled SPZ 1 (50 day travel time) to SPZ 3 (total catchment) of a major public water supply Chalk abstraction (28/39/43/0019) located approximately 0.7km distance to the south (see Vol 24 Figure 13.4.2 in see separate volume of figures). The CSO drop shaft would be constructed in SPZ 2 (400 day travel time) of this Chalk source. The distance from the CSO drop shaft location to the boundary of SPZ 1 is less than 80m. The abstraction is located up the regional hydraulic gradient expected beneath the CSO drop shaft site although the abstraction itself is likely to reverse the regional groundwater flow direction at Greenwich Pumping Station so that flow is towards the southeast.

Environmental designations

13.4.19 There are no designations relevant to groundwater within 1km of the site.

Groundwater quality and land quality

13.4.20 Historical land use mapping at the Greenwich Pumping Station site, reviewed as part of the land quality assessment, identified a number of potentially contaminative off site uses (Vol 24 Section 8).

13.4.21 The baseline groundwater quality data presented in Vol 24 Appendix K, Vol 24 Table K.7 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 off site (located 29m from the site) and up to 1km away (SR1018D, SR1024, PR1023, SR4087, SR1019, SR6902D, SA4031, SR4117, SR1021C, SR1025B, SR1026 and SR1044B) (for locations see Vol 24 Figure 13.4.1 in separate volume of figures) and within the River Terrace Deposits and Chalk. The data has been compared with the UK drinking water standards[6] or relevant Environmental Quality Standards (EQS) (Defra, 2010)[7].

13.4.22 The data shows exceedances of the relevant standards for chloride, iron, manganese, nickel, polycyclic aromatic hydrocarbons (PAH's) and sulphate within the River Terrace Deposits at SA4031 (located at 380m from the site). The data also shows exceedances within the Chalk with respect to total aromatic hydrocarbons, heavy metals, PAHs, pesticides, herbicides and turbidity at various boreholes located between 29m and 68m distance from the site. PAHs may be formed during a range of human activities, including incomplete combustion of carbon-based fuels and other industrial processes (EA, 2010)[8]. In addition, PAHs are considered to be Priority Hazardous Substances under the Water Framework Directive (Commission of the European Communities, 2009)[9].

13.4.23 The data also suggest that brackish conditions exist within the River Terrace Deposits at SA4031 (located at 380m from the site) and within the Chalk at SR1024 and SR4087, due to the proximity of the Deptford Creek and tidal Thames. However the presence of the major public water supply source 0.7km to the south of the site suggests that these conditions are localised. Further details are included in Vol 24 Appendix K.7.

13.4.24 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)[10] (soil guideline values designed to be protective of human health) within the River Terrace Deposits at SR1019 and SA4031 with respect to hydrocarbons and PAHs and within the Thanet Sands at SR1025B and SR1026 with respect to hydrocarbons. Further detail is provided in the land quality assessment (see Vol 24 Section 8 and Appendix F).

Groundwater flood risk

13.4.25 There are no reported incidences of groundwater flooding in the vicinity of the site, based on information from the Royal Borough (RB) of Greenwich Strategic Flood Risk Assessment (SFRA) (JBA, 2011)[11].

Groundwater receptors

13.4.26 Groundwater receptors which could be affected during construction or operation are summarised in Vol 24 Table 13.4.3 Groundwater – receptors below. Both the upper and lower aquifers have been assessed as receptors as both would be penetrated by the CSO drop shaft at the Greenwich Pumping Station site. There are three abstraction sources from the Chalk within 1km radius of the site and which have also been assessed for the construction phase.

Vol 24 Table 13.4.3 Groundwater – receptors

Receptor	Construction	Operation	Comment
Groundwater body – upper aquifer	✓	✓	Penetrated by CSO drop shaft, interception chamber & culvert
Groundwater body – lower	✓	✓	CSO drop shaft and base slab extend

Receptor	Construction	Operation	Comment
aquifer			into lower aquifer
Licensed abstractions – lower aquifer	✓	✗	Three licensed abstractions at 0.7-0.9km from site
Licensed abstractions - upper aquifer	✗	✗	No licensed abstractions within 1km of site
Unlicensed abstractions	✗	✗	No known unlicensed abstractions within 1km radius of site
Planned developments and abstractions	✗	✗	No planned licensed abstractions or Ground Source Heat Pumps (GSHPs)

Symbols ✓ applies ✗ does not apply

Receptor sensitivity

13.4.27 The upper aquifer is classified by the EA as a secondary A aquifer and is allocated a medium value in terms of quantity in this assessment. The upper aquifer has brackish water quality as a result of its location close to the Deptford Creek and tidal Thames and so is categorised as being of low value with regard to quality.

13.4.28 The lower aquifer is a principal aquifer as classified by the EA, and so is categorised as being of high value with regard to quantity. While the baseline groundwater quality data suggests brackish conditions and contamination in the vicinity of the site, the presence of a major public water supply source 0.7km away suggests that these conditions are localised. Therefore the lower aquifer is determined to be of high importance with regard to quality.

13.4.29 The sensitivity of individual abstraction licences has been assessed depending on their use, for example, a higher value is given to sources used for drinking water than for industrial purposes, which in turn are given a higher value than for amenity purposes. Also larger public water supply abstractions are given a higher value than generally smaller domestic supplies.

13.4.30 A summary of receptor sensitivities used in the assessments that follow are included in Vol 24 Table 13.4.4 below.

Vol 24 Table 13.4.4 Groundwater – receptor value/ sensitivity

Receptor	Value/sensitivity
Groundwater quality	
Upper aquifer	Low value; secondary A aquifer with brackish

Receptor	Value/sensitivity
	conditions and no licensed abstractions within 1km of site.
Lower aquifer	High value; principal aquifer and within SPZ 1 of public water supply source.
Groundwater quantity (resources)	
Upper aquifer	Medium value; secondary A aquifer.
Lower aquifer	High value; principal aquifer.
Licensed Chalk abstraction 28/39/43/0019	High value; drinking water supply source.
Licensed Chalk abstractions TH/39/44/0003 and TH/39/44/0006	High value; GSHP non-evaporative cooling purposes.

Construction base case

13.4.31 The construction base case in Site Year 1 is as per the current baseline and also includes any developments that are likely to be complete and partially or fully operational during construction at the Greenwich Pumping Station site and would have the potential to lead to a change to groundwater in the upper and lower aquifers.

13.4.32 The basements associated with other developments identified in Vol 24 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.

13.4.33 None of the proposed developments identified in Vol 24 Table 13.3.1 would impact on the lower aquifer and it can be concluded that there would be no change to the base case in Site Year 1 of construction.

Operational base case

13.4.34 The operational base case is as per the construction base case. Therefore it can be concluded that there would be no change to the base case on Year 1 of operation in terms of groundwater flow in both the upper and lower aquifers.

13.5 Construction effects assessment

Construction impacts

Dewatering of aquifers

13.5.1 Localised dewatering of the River Terrace Deposits may be required for the construction of the interception works. However dewatering would be required within the secant pile walls which would be constructed around the interception works at Greenwich Pumping Station site. No licensed abstractions have been identified; therefore the magnitude of this impact on the upper aquifer has been anticipated to be negligible.

13.5.2 For the construction of the Thames Tideway Tunnel as a whole, groundwater levels in the lower aquifer would have to be lowered by dewatering to allow construction of the main tunnel shafts, CSO drop 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 Section 10 Appendix K.2) and the effects, where they are of relevance to the Greenwich Pumping Station site, are included in this assessment.

13.5.3 The design at the Greenwich site uses diaphragm walls that hydraulically isolate the inside of the CSO drop shaft from the surrounding ground. The amount of dewatering which would be needed at the Greenwich Pumping Station site is estimated at less than 200m^3/d and would be pumped from within the diaphragm walls ("internal dewatering"). Any drawdown within the shaft would be isolated from water levels outside the diaphragm wall and it is anticipated that these levels would only be lowered by a few centimetres (based on experience from the Lee Tunnel project [WJ Groundwater, 2012])[12].

13.5.4 Details of the groundwater modelling undertaken to inform the assessment of likely significant effects at the Greenwich Pumping Station site are included in Vol 3 Appendix K.2. The groundwater level monitoring (see the draft groundwater monitoring strategy in Vol 3 Appendix K.1) already reflects the pumping from the public water supply source located to the south (see para. 13.4.17).

13.5.5 In addition to the limited dewatering at the Greenwich Pumping Station site CSO drop shaft described above, there would also be drawdown (lowering of groundwater levels) of the lower aquifer as a result of project-wide dewatering. The full details of the effects on licensees in the vicinity of the Greenwich site are set out in the modelling report (see Vol 3 Appendix K.2) and are summarised below. For each licensee the impact of the predicted drawdown is assessed by comparing it to the maximum assessed available drawdown (MAAD)[xiii] at the licensee's borehole(s).

a. In the case of licence number 28/39/43/0019 (Thames Water Utilities Ltd.), modelling has predicted a maximum drawdown of 0.7m, which is less than the MAAD of 5m. The magnitude of impact has been assessed to be negligible.

b. In the case of licence number TH/39/44/0003 and TH/39/44/0006 (Trustees of National Maritime Museum), modelling has predicted a maximum drawdown of0. 7m, this less than the MAAD of 10m. The magnitude of impact has been assessed to be negligible.

[xiii] Maximum assessed 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 ever is least of these two values.

Groundwater quality

13.5.6 The baseline groundwater quality data from nearby ground investigation boreholes show exceedances in the River Terrace Deposits and in the Chalk with respect to chloride and sodium, indicating brackish conditions. However the presence of a major public water supply within a kilometre to the south of the Greenwich Pumping Station site suggests that these conditions are localised. These brackish conditions are to be expected given the location close to the Deptford Creek and tidal Thames and that there is a known hydraulic connection between surface water and groundwater between Greenwich and Woolwich (see published information in Vol 3 Section 13).

13.5.7 The data also show exceedances with respect to heavy metals, hydrocarbons, PAHs, pesticides, herbicides and turbidity in groundwater within the Chalk at ground investigation and monitoring boreholes located between 29m and 68m from the site.

13.5.8 The CSO drop shaft construction may create a pathway for groundwater movement between the CSO drop shaft and the ground, where an effective seal is not in place. However, the diaphragm wall would seal out the upper aquifer and any water encountered would be pumped out and disposed of appropriately, following the measures identified within the *CoCP* (and detailed in Section 13.2). Given the preceding approach, the magnitude of the impact on the upper aquifer has been assessed to be negligible.

13.5.9 In addition, there is the potential for poor quality groundwater to migrate and to further degrade groundwater quality in the lower aquifer. The nearest licensed abstraction is located to the south, up hydraulic gradient of the CSO drop shaft site and therefore would not be at risk. In addition, any dewatering of the lower aquifer would be internal to the diaphragm walls and that any water encountered would be pumped out and disposed of appropriately, following the measures identified within the *CoCP* (and detailed in Section 13.2), the magnitude of the impact on the lower aquifer has been assessed to be negligible.

13.5.10 The potential for movement of contamination at the Greenwich Pumping Station site by project-wide dewatering is discussed in Vol 3 Section 13. A quantitative risk assessment to address the effect on the wider water environment would be undertaken for the site and approved by the EA prior to works commencing.

13.5.11 Ground treatment is anticipated to be required within the upper aquifer for the construction of the interception chamber works where the excavation spans the existing sewer. However given that internal dewatering would minimise the potential movement of grout contaminated groundwater, the impact on groundwater quality within the upper aquifer has been assessed to be negligible.

13.5.12 Ground treatment is anticipated to be required within the Chalk for the drop shaft construction and to facilitate the break out of the TBM. While the *CoCP* would stipulate acceptable materials and practices, fissure grouting in high transmissivity chalk within a SPZ 1 would have the potential to impact groundwater quality at a major public water supply source. However, given that internal dewatering would limit the potential movement of grout contaminated groundwater, the impact on groundwater quality within the lower aquifer has been assessed to be negligible.

13.5.13 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. Project-wide dewatering within the lower aquifer would draw water levels down at the Greenwich site by less than 1m and this level of drawdown at Greenwich is not anticipated to result in the water level dropping below the top of the Thanet Sands. The magnitude of this project-wide impact on groundwater quality has been anticipated to be negligible and has been dealt with further in Vol 3 Section 10.

Physical obstruction

13.5.14 The construction of underground structures may disrupt local groundwater flows and alter groundwater levels in both the upper and lower aquifers.

13.5.15 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 Greenwich Pumping Station by approximately 0.3m, based on an estimated hydraulic gradient of 0.004.

13.5.16 Based on the limited available data, groundwater levels in the upper aquifer can reach 98mATD, which is approximately 5.4m below the existing ground surface at the Greenwich site (around 103.4mATD). Given the small predicted rise in water levels (0.3m) on the northwest side of the Greenwich Pumping Station site, the change in groundwater levels as a result of the physical obstruction would result in a negligible impact on the upper aquifer.

13.5.17 The diaphragm walls used to construct the CSO drop shaft would extend into the lower aquifer by approximately 34m and would have an external diameter of approximately 22m. The lower aquifer is however extensive and deep and the physical obstruction is relatively small in comparison. In addition, the potential impact of obstruction would be reduced by virtue of the distance to the nearest abstraction point of 0.7km. The impact on the lower aquifer and on this source is assessed as being negligible.

Construction effects

13.5.18 By combining the impacts identified above with the receptor importance in Vol 24 Table 13.4.4 Groundwater – receptor value/ sensitivity, the significance of the effects can be derived using the generic significance matrix (Vol 2 Section 2). The results are described in the following sections.

Dewatering of aquifers

13.5.19 Localised dewatering of the upper aquifer may be required; however this would be internal to diaphragm walls or secant pile walls, and there are no licensed abstraction sources from the upper aquifer located within 1km of the Greenwich Pumping Station site. The negligible impact of dewatering on a medium value receptor, the upper aquifer for groundwater quantity would lead to a **negligible** effect.

13.5.20 Dewatering of the lower aquifer would be internal to the diaphragm walls and small in volume. Lower aquifer is classified as a high value receptor in terms of groundwater resources. A negligible impact on this high value receptor would result in a **minor adverse** effect.

13.5.21 In addition, the project-wide effects of dewatering would not result in exceedances of the MAAD at the licensed abstraction sources from the lower aquifer located within 1km radius of the Deptford Church Street site, 28/39/42/0019, TH/39/44/0003 and TH/39/44/0006. The negligible impacts of dewatering on these high value receptors would lead to **minor adverse** effect.

Groundwater quality

13.5.22 No groundwater contamination has been identified within the upper aquifer in close proximity to the Greenwich Pumping Station site and the use of diaphragm wall or secant pile wall construction techniques would limit any movement of contaminated groundwater should it be encountered. The negligible impact on the groundwater quality of a medium value receptor, the upper aquifer, would lead to a **negligible** effect.

13.5.23 Grouting is anticipated to be required within the upper aquifer; however the diaphragm walls or secant pile walls would limit the movement of any contaminated groundwater. The negligible impact on groundwater quality on a medium value receptor, the upper aquifer, would lead to a **negligible** effect.

13.5.24 Groundwater contamination has been identified within the lower aquifer in close proximity to the Greenwich Pumping Station site; however dewatering of the lower aquifer would be internal to the diaphragm walls thereby limiting any movement of contaminated groundwater. The negligible impact on the groundwater quality of a high value receptor, the lower aquifer, would lead to a **minor adverse** effect.

13.5.25 Fissure grouting is anticipated to be required within the Chalk, which would have the potential to impact groundwater quality at a major public water supply source; however the diaphragm walls would limit any movement of contaminated groundwater. The negligible impact on the groundwater quality of a high value receptor, the lower aquifer, would lead to a **minor adverse** effect.

13.5.26 No drawing down of groundwater levels below the top of the Thanet Sand is anticipated at the Greenwich Pumping Station site and so there should be no deterioration of groundwater quality associated with this. This negligible impact on the groundwater quality of a high value receptor, the lower aquifer, would lead to a **minor adverse** effect.

Physical obstruction

13.5.27 The 0.3m rise in groundwater levels in the upper aquifer as a result of obstruction is small compared to the estimated unsaturated zone at the

CSO shaft site. This negligible impact on a medium value receptor, the upper aquifer would lead to a **negligible** effect.

13.5.28 The physical impact of the CSO drop shaft upon the lower aquifer as a result of obstruction can be considered negligible given the extent and thickness of the lower aquifer and the distance to the nearest licensed abstraction source. A negligible impact on a high value receptor, the lower aquifer with regard to quantity, would result in a **minor adverse** effect.

13.6 Operational effects assessment

Operational impacts

Physical obstruction

13.6.1 The presence of the operational CSO drop shaft, the connection culvert and other chambers in the upper aquifer may disrupt local groundwater flow and alter groundwater levels.

13.6.2 The method for assessing the impact of the CSO 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 Greenwich Pumping Station by less than 0.1m, based on an estimated hydraulic gradient of 0.004.

13.6.3 The predicted rise in water levels within the upper aquifer of less than 0.1m on the northwest side of the structure is small compared to the estimated unsaturated zone within the upper aquifer of approximately 5.4m. Therefore the magnitude of this impact on the upper aquifer has been assessed as negligible.

13.6.4 The CSO drop shaft would extend down approximately 34m into the lower aquifer and with an external diameter of 22m. The physical impact of the shaft upon the lower aquifer as a result of obstruction can be considered negligible given the areal extent and thickness of the lower aquifer and the distance to the nearest licensed abstraction source.

Seepage from CSO drop shaft

13.6.5 An estimate of the theoretical seepage volumes from the CSO drop shaft at Greenwich Pumping Station 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 drop shaft into the upper aquifer is 4.1m^3/annum (Vol 2 Appendix K, Vol 2 Table K.5). The higher heads outside the CSO drop shaft mean that any risk of seepage from the CSO drop shaft into the upper aquifer would be further reduced. The magnitude of impact has been assessed as negligible for the upper aquifer.

13.6.6 The estimated volume of seepage from the CSO drop shaft into the lower aquifer is 20m^3/annum (Vol 2 Appendix K, Vol 2 Table K.5). The magnitude of impact has been assessed as negligible for the lower aquifer.

Seepage into CSO drop shaft

13.6.7 An estimate of the theoretical seepage volumes into the CSO drop shaft at Greenwich Pumping Station is included in Vol 2 Appendix K.3. The estimated loss of water resources from the upper aquifer into the shaft would be 137m^3/annum (Vol 2 Appendix K, Vol 2 Table K.4) and the magnitude of the impact on the upper aquifer has been assessed as negligible.

13.6.8 The estimated loss of water resources from the lower aquifer is 683m^3/annum which is considered to be a negligible impact.

13.6.9 No other operational impacts are envisaged.

Operational effects

13.6.10 By combining the receptor value (Vol 24 Table 13.4.4) with the impacts identified above, the significance of the effects can be derived using the generic significance matrix (Vol 2 Section 2). The results are described in the following sections.

Physical obstruction

13.6.11 Altering the groundwater levels on the northwest side of the CSO drop shaft is a negligible impact, on a medium value receptor (upper aquifer) and would lead to a **negligible** effect on groundwater quantity in the upper aquifer.

13.6.12 The negligible impact of physical obstruction, on a high value receptor (lower aquifer), would lead to a **minor adverse** effect on groundwater quantity in the lower aquifer.

Seepage from CSO drop shaft

13.6.13 Seepage from the drop shaft has been determined as a negligible impact, which on a medium value receptor (the upper aquifer), would lead to a **negligible** effect on water quality in the upper aquifer. The same impact on a high value receptor (the lower aquifer) would lead to a **minor adverse** effect on groundwater quality in the lower aquifer.

Seepage into CSO drop shaft

13.6.14 Seepage into the drop shaft has been determined as a negligible impact, which on a medium value aquifer (the upper aquifer) would lead to a **negligible** effect on water quantity in the upper aquifer. The same impact on a high value receptor (the lower aquifer), would lead to a **minor adverse** effect on groundwater quantity in the lower aquifer.

13.7 Cumulative effects assessment

Construction effects

13.7.1 One of the developments identified in Vol 24 Table 13.3.1 could give rise to cumulative effects to groundwater in the upper aquifer through the inclusion of basements. Although there may be a local impact on groundwater levels in the upper aquifer due to the vicinity of the development, any impacts are not expected to be significant and any 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 on the lower aquifer. The effects on groundwater during construction would remain as described in Section 13.5.

Operational effects

13.7.3 No cumulative operational effects assessment is required as development schemes identified already form part of the base case prior to the operational phase of the Thames Tideway Tunnel project. Therefore, the effects on groundwater during operation would remain as described in Section 13.6.

13.8 Mitigation

13.8.1 There are few impacts from the construction phase and those which have been identified would have negligible or minor adverse effects. No mitigation is therefore required.

13.8.2 Similarly no significant effects are identified in the operational assessment and no mitigation is required.

13.8.3 The potential for movement of contamination at the Greenwich Pumping Station site by project-wide dewatering is discussed in Vol 3 Section 13.

13.9 Residual effects assessment

Construction effects

13.9.1 As no mitigation measures are required, the residual construction effects remain as described in Section 13.5. All residual effects are presented in Section 13.10.

Operational effects

13.9.2 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 24 Table 13.10.1 Groundwater – construction assessment summary

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Upper aquifer (licensed Chalk abstractions)	Lowering of groundwater levels	Negligible	None	Negligible
Lower aquifer (licensed Chalk abstractions)	Lowering of groundwater levels in the Chalk resulting from dewatering	Lower aquifer – Minor adverse 28/39/43/0019 – Minor adverse TH/39/44/0003 and TH/39/44/0006 – Minor adverse for both	None	Minor adverse
Upper aquifer (groundwater quality)	Deterioration in groundwater quality caused by creation of a pathway	Negligible	None	Negligible
	Deterioration in water quality from grouting	Negligible	None	Negligible
Lower aquifer (groundwater quality)	Deterioration in groundwater quality caused by creation of a pathway	Minor adverse	None	Minor adverse
	Deterioration in water quality in the Chalk from grouting	Minor adverse	None	Minor adverse
Upper aquifer	Change in groundwater storage and flood risk as a result of physical obstruction	Negligible	None	Negligible
Lower aquifer	Change in groundwater storage as a result of physical obstruction	Minor adverse	None	Minor adverse

Vol 23 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	Deterioration in water quality in the upper aquifer from seepage out of drop shaft	Negligible	None	Negligible
Lower aquifer	Deterioration in water quality in the lower aquifer from seepage out of drop shaft	Minor adverse	None	Minor adverse
Upper aquifer	Seepage into drop shaft affecting groundwater resources	Negligible	None	Negligible
Lower aquifer	Seepage into drop shaft affecting groundwater resources	Minor adverse	None	Minor adverse

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 levels contours in Chalk*. Received from Environment Agency, (June 2011).

[5] British Geological Survey. *British geology onshore digital maps 1:50 000 scale*. Received from Thames Tunnel, February 2009.

[6] *The Water Supply (Water Quality) Regulations*,(2000). Available at: http://www.legislation.gov.uk/uksi/2000/3184/contents/made

[7] Defra. River Basin Districts Typology, Standards and Groundwater Threshold Values (Water Framework Directive) (England and Wales) Direction (2010). Available at: http://www.defra.gov.uk/environment/quality/water/legislation/water-framework-directive/

[8] Environment Agency. *REACH Annex XVII Restrictions Polycyclic-aromatic Hydrocarbons (PAHs) Guidance Note Part 1* (October 2010). Available at: http://www.environment-agency.gov.uk/static/documents/Business/Part_1_PAH_Guidance_Note.pdf

[9] Commission of the European Communities. *Directive of the European Parliament and of the Council on environmental quality standards in the field of water policy and amending Directive 2000/60/EC*. (2009). Available at: http://ec.europa.eu/environment/water/water-dangersub/pdf/com_2006_397_en.pdf?lang=_e

[10] Environment Agency. *Soil Guideline Value Reports* (2009). Available at: http://www.environment-agency.gov.uk/research/planning/64015.aspx

[11]JBA consulting. *Royal Borough of Greenwich Level 1 Strategic Flood Risk Assessment*. (October 2011)

[12] WJ Groundwater. *Lee Tunnel Abbey Mills Shaft F Pump Out Test Factual Report. 432/1770* (March 2012).

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

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Section 14: Water resources - surface water

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Thames Tideway Tunnel

Environmental Statement

Volume 24: Greenwich Pumping Station 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 Greenwich Pumping Station 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 River Thames [tidal Thames]) due to:

a. construction activities

b. operation of the main tunnel and Greenwich connection 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 of this volume. 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 Greenwich Pumping Station site and in particular in relation to the interception of the Greenwich Pumping Station combined sewer overflow (CSO). It is however important to recognise that whilst the reductions in spills from the Greenwich Pumping Station 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 proposed 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 24 Greenwich Pumping Station 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 majority of the Greenwich Pumping Station site is located within the boundary of the existing Thames Water Greenwich Pumping Station, adjacent to Deptford Creek, approximately 500m from the tidal Thames. A CSO drop shaft and the Greenwich connection tunnel would be constructed at the site. Excavated material would be processed onsite prior to being exported via road (as shown on the Construction plans, see separate volume of figures – Section 1).

14.2.3 Based on the geology at the site, the construction of the drop shaft and associated infrastructure would require dewatering and/or ground treatment. Internal dewatering of the drop shaft diaphragm is proposed to limit the volume of dewatering required. Disposal of dewatering effluent can have an impact on surface water. See Section 13 of this volume for further details on the dewatering requirements.

Code of construction practice

14.2.4 There is an indirect pathway for pollutants to be discharged to the tidal Thames via surface water drains. 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.

14.2.5 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.

14.2.6 All site drainage would be drained and discharged to existing combined sewers. Foul drainage from the site welfare facilities would be connected to the mains combined sewer.

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[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).

14.2.7 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*).

14.2.8 There are no site-specific measures incorporated in the *CoCP* Part B (Section 8) relevant to the surface water assessment. There is a measure in the *CoCP* Part B (Section 8) that relates to permeable hardstanding that is only of relevance to the FRA contained in the Section 15 of this volume.

Operation

14.2.9 The operation of the main tunnel would enable the interception of combined sewage generated during storms which would otherwise discharge to the tidal Thames from the Greenwich Pumping Station CSO. There would therefore be a reduction in the frequency, duration and volume of spills from this CSO.

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 Section 14. A WFD assessment for the project as a whole is presented in Vol 3 Appendix L.2.

Engagement

14.3.2 Vol 2 documents the overall engagement which has been undertaken in preparing the *Environmental Statement*. Vol 2 Section 14 summarises the engagement that has been undertaken for the surface water assessment and the consultation responses relevant to surface water.

14.3.3 There are no site-specific engagement comments relevant to the surface water assessment at Greenwich Pumping Station.

Baseline

14.3.4 The baseline methodology follows the methodology described in Vol 2 Section 14. There are no site-specific variations for identifying baseline conditions for this site.

Construction

14.3.5 The assessment methodology for the construction phase follows that described in Vol 2 Section 14. There are no site-specific variations for undertaking the construction assessment of this site.

14.3.6 The assessment year for construction effects is Site Year 1 (2017) when construction would commence. No modelled water quality data are available for this year. The water quality conditions for the base case have therefore been derived from available modelled simulation data which uses population projections for 2021. This assumption is considered reasonable as substantial changes in water quality are considered unlikely between 2017 and 2021.

14.3.7 The Lee Tunnel and the sewage works upgrades at Mogden, Beckton, Crossness, Long Reach and Riverside sewage treatment works (STWs) would be operational by the time construction of the Thames Tideway Tunnel project commences, as described in Vol 2 Section 14. Significant improvements in the water quality in the tidal Thames are anticipated as a result of these projects. Both the construction base case and the operational base case would be the water quality in the tidal Thames with the Lee Tunnel and sewage works upgrades in place.

14.3.8 The construction base case has considered the developments that are scheduled to be complete and in operation by Site Year 1 (presented in Vol 24 Appendix N). The developments in Vol 24 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 as outlined above.

14.3.9 Phases of some of the developments identified in Vol 24 Appendix N would be under construction during Site Year 1. These developments have been considered in the cumulative effects assessment (see Section 14.7).

14.3.10 The assessment area for the assessment of effects of construction activities at the Greenwich Pumping Station site would be limited to one section of the river, namely the Thames Middle waterbody (incorporating Deptford Creek) listed below in Vol 24 Table 14.4.1.

14.3.11 Section 14.5 details the likely significant effects arising from the construction at the Greenwich Pumping Station site. There are no other Thames Tideway Tunnel project sites which could give rise to additional effects on surface water within the assessment area for this site, therefore no other Thames Tideway Tunnel project sites are considered in this assessment.

Operation

14.3.12 The assessment methodology for the operation phase follows that described in Vol 2 Section 14. There are no site-specific variations for undertaking the operational assessment of this site.

14.3.13 The assessment year for operation effects is Year 1 of operation. As with the construction assessment, the operational assessment also relies on modelled water quality data which uses population projections for 2021. In addition, the influence of climate change on the proposed development has been assessed in 2080.

14.3.14 As noted above, the operational base case would be the water quality in the tidal Thames with the Lee Tunnel and sewage works upgrades in place. The operational base case has considered the developments that are scheduled to be complete and in operation by Year 1 of operation (presented in Vol 24 Appendix N). The developments in Vol 24 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 (Section 14.7). The operational assessment uses the same assessment area identified above for the construction assessment.

14.3.16 Section 14.6 details the likely significant effects arising from the operation at the Greenwich Pumping Station site.

Assumptions and limitations

14.3.17 The assumptions and limitations associated with this assessment are presented in Vol 2 Section 14. Based on the geology at the site, it is assumed 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[ii], is included in Vol 24 Table 14.4.1 below.

[ii] The EA has provided advice on CSO excursion areas[ii], which states that CSOs below Tower Bridge will only impact the Thames Middle waterbody and those upriver of Tower Bridge will impact both the Thames Upper and Thames Middle waterbodies.

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 24 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 Middle (incorporating Deptford Creek) GB530603911402	Heavily modified	Moderate potential	Fail	Moderate potential	Fail	Good

14.4.4 The River Thames and its tidal Tributaries are designated as a Site of Importance for Nature Conservation (Grade III of Metropolitan Importance). The Thames Middle waterbody (which incorporates the Deptford Creek) stretches from Battersea Bridge to Mucking Flats. It is considered to be a high value waterbody although the 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 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 Greenwich Pumping Station site.

14.4.7 The Greenwich Pumping Station site lies between two EA spot sample sites. It is approximately 250m downstream of the Ravensbourne at Deptford Bridge point and approximately 250m upstream of Greenwich, as shown on Vol 24 Figure 14.4.1 (see separate volume of figures). Summary data from these monitoring points, 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 24 Table 14.4.2.

Vol 24 Table 14.4.2 Surface water – spot samples

EA spot sample site	DO (mg/l) (10%)	Ammonium (mg/l) (90%)
Ravensbourne at Deptford Bridge	Not measured	5.13
Thames at Greenwich	3.59	10.22

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 Greenwich Pumping Station CSO discharges directly to the tidal Thames and 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 Greenwich Pumping Station CSO outfall and a more widespread effect along the tidal Thames of rapidly dropping DO levels. Vol 3 Section 14 details half-tide plots displaying the changes in DO levels along the tidal Thames.

14.4.10 Historical mapping has identified that the area surrounding the site has been heavily developed with a mix of industrial and residential properties since the 19th century, although the review recorded no potentially contaminative activities (other than the pumping station) that are considered to have impacted the site directly.

14.4.11 Ground investigation carried out at the Greenwich Pumping Station site has indicated the presence of a range of contaminants above approved limits[iii] . 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 Greenwich Pumping Station CSO has been characterised using the catchment model of the sewer system (See Vol 3 Section 14 for further details of catchment modelling), and the annual average duration, frequency and volume of spill has been defined as follows:

a. the CSO spills on average 51 times in the Typical Year[iv]

b. the CSO spills for a total duration of 672 hours in the Typical Year

c. the spill volume from the CSO is approximately 8,320,000m^3 in the Typical Year, representing 21% of the total volume discharged to the tidal Thames in the Typical Year from all CSOs.

14.4.13 Using the same model of the sewer system, 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 Greenwich Pumping Station CSO has been defined as follows:

a. the CSO discharges 2,085,000kg of BOD in the Typical Year

b. the CSO discharges 59,000kg of ammonia in the Typical Year

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iii In order to assess potential risk to aquatic organisms, 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

c. the CSO discharges 275,000kg 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)[9]. 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 51 spills per annum from the Greenwich Pumping Station CSO occur on separate days, there could be up to a maximum of 204 days per typical year where recreational users are at risk of exposure to pathogens in the vicinity of the outfall as a result of the Greenwich Pumping Station CSO spills alone (Lane, C, Surman-Lee, S, Sellwood, J and Lee, JV., 2007)[10].

14.4.16 The operation of the Greenwich Pumping Station 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 Greenwich Pumping Station CSO and assuming litter tonnages are proportional to discharge volumes, this would indicate that approximately 2,100t of sewage derived litter is discharged from the Greenwich Pumping Station CSO in the Typical Year. An assessment of the 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 Section 14.3 would not change since no new sensitive receptors would be introduced.

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.

[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.

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 Greenwich Pumping Station CSO would have decreased (as a result of expansion to the capacity of Crossness STW) as follows:

a. the CSO would spill 28 times in the Typical Year (23 less than the current baseline)

b. the CSO would spill for 240 hours in the Typical Year (432 hours less than the current baseline)

c. the spill volume from the CSO would be approximately 3,940,000m^3 in the Typical Year (4,380,000m^3 less 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 decreased (as a result of the Lee Tunnel and the sewage works upgrades from the current baseline as follows:

a. the CSO would discharge 789,000kg of BOD in the Typical Year (1,296,000kg less than the current baseline)

b. the CSO would discharge 25,000kg of ammonia in the Typical Year (34,000kg less than the current baseline)

c. the CSO would discharge 111,400kg of TKN in the Typical Year (165,600kg less 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 days in which river users would be expose to pathogens during the operational base case year (taking into account 2021 modelled assumptions) would be a maximum of 112 days in the Typical Year as a result of spills from the Greenwich Pumping Station CSO alone.

14.4.24 Similarly, the tonnage of sewage derived litter discharged from the Greenwich Pumping Station CSO can be expected to decrease by approximately 53%, from approximately 2,100t to approximately 995t in the Typical Year.

14.5 Construction effects assessment

14.5.1 This section presents the construction impacts that could occur at the site and identifies where no further assessments 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

Surface water drainage

14.5.2 The majority of the CSO drop shaft would be excavated through Chalk and therefore it is likely that the excavated material would contain high moisture content. It is possible that there could be some spillage/leakage of excavated material.

14.5.3 There is an indirect pathway to the river for contaminated runoff, high suspended solids and other content 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.

Dewatering

14.5.4 Ground investigation of the site indicates presence of several contaminants. An assessment of potential on-site contamination is provided within Section 8 of this volume.

14.5.5 The base of the proposed drop shaft would reach the underlying chalk aquifer. Internal dewatering of diaphragm wall is proposed, which would limit the amount of dewatering required to less than 200m^3 per day. 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. Settlement of suspended solids within the dewatering would minimise the levels of 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 and it is therefore considered that there is no pollution pathway and hence no impact from dewatering.

Construction effects

14.5.6 The assessment above has not identified any potential impacts as a result of the proposed development, therefore no significant construction effects have been identified for the construction phase at this site.

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 Greenwich Pumping Station 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 Greenwich Pumping Station CSO would substantially decrease (as a result of the combined sewer overflows flow into the main tunnel) as follows:

a. the CSO would spill on average four times per typical year (24 times less than the operational base case)

b. the CSO would spill for an average duration of 36 hours (204 hours less than the operational base case)

c. the spill volume from the CSO would be approximately 573,000m^3 per typical year (3,367,000m^3 less than the operational base case).

14.6.3 The frequency, duration and volume of spills at the Greenwich Pumping Station site would therefore be reduced by approximately 85% 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 Greenwich Pumping Station CSO would be a maximum of 16 days in the Typical Year (a reduction of up to 96 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 85%, from approximately 995t to approximately 145t, 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 89,000kg of BOD in the Typical Year (700,000kg less than the operational base case)

b. the CSO would discharge 2,800kg of ammonia in the Typical Year (22,200kg less than the operational base case)

c. the CSO would discharge 12,400kg of TKN in the Typical Year (99,000kg 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 to population) predicts that by 2080 with the operational Thames Tideway Tunnel, the frequency, duration and volume of the Greenwich Pumping Station CSO would be the following:

a. the CSO would spill on average five times per typical year (once more than the Year 1 of operation development case)

b. the CSO would spill for an average duration of 46 hours (10 hours more than the Year 1 of operation development case)

c. the spill volume from the CSO would be approximately 772,000m^3 per typical year (199,000m^3 more than the Year 1 of operation development case).

14.6.1 In summary, the model predicts that in the 2080 development case scenario the Greenwich Pumping Station CSO at Greenwich Pumping Station site would increase in spill frequency, 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.

14.6.2 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 this site assessment.

Operational effects

14.6.3 The potential surface water impacts identified above as a result of operation at the Greenwich Pumping Station 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 24 Table 14.4.1.

14.6.4 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.

14.6.5 The significance of these effects has then been assessed based on the magnitude of the impacts as described in Vol 2 Section 14.5.

Reduction in Greenwich Pumping Station CSO spills

14.6.6 The reduction in spills from the Greenwich Pumping Station CSO would represent an important contribution towards:

a. meeting the requirements of the UWWTD[11] in relation to the Greenwich Pumping Station 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.

14.6.7 Therefore, the reduction in spills would be a **major beneficial** effect most notably in the context of the UWWTD. It should be noted that, as explained in Section 14.1, the water quality in the vicinity of the Greenwich Pumping Station site also depends on the project-wide improvements, as documented in Vol 3 Section 14.

14.6.8 The associated reduction in exposure to pathogens would greatly improve the conditions for recreational users of the tidal Thames around the Greenwich Pumping Station, 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.

14.6.9 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.

14.7 Cumulative effects assessment

14.7.1 Considerable improvements in the water quality of the tidal Thames will occur as a result of the works associated with the Lee Tunnel and sewage works upgrades. These already form part of the base case and so are not considered as part of the assessment of cumulative effects.

14.7.2 Of the developments presented in Vol 24 Appendix N, which could potentially give rise to cumulative construction effects with the proposed development at the Greenwich Pumping Station site, it is not considered that any would lead to cumulative effects on surface water. This is because no significant effects are considered likely for the construction phase and the other developments are not of sufficient scale such that they are likely to generate significant effects in relation to surface water quality

14.7.3 As explained in Section 14.3, no developments have been identified that would be under construction during Year 1 of operation, therefore a cumulative effects assessment has not been undertaken for the operational phase.

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 24 Table 14.10.1 Surface water – construction assessment summary

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Thames Middle (including Deptford Creek)	The assessment has not identified any significant adverse effects.	N/A	N/A	N/A

Vol 24 Table 14.10.2 Surface water – operational assessment summary

Receptor	Effect	Significance of effect	Mitigation	Significance of residual effect
Thames Middle (including Deptford Creek)	Compliance with UWWTD and WFD. Improved water quality in the vicinity of the Greenwich Pumping Station CSO by reduced pollutant loading and no reduction of DO levels due to reduced spill frequency, duration and volume from the Greenwich Pumping Station CSO	Major beneficial	None	Major beneficial
Thames Middle (including Deptford Creek)	Risk of exposure days to pathogens would be reduced to a maximum of 16 days in the Typical Year (a reduction of up to 96 days of risk of exposure)	Moderate beneficial	None	Moderate beneficial
Thames Middle (including Deptford Creek)	Sewage derived litter discharge at Greenwich Pumping Station CSO would be reduced by approximately 85% improving the aesthetic quality of the river locally	Moderate beneficial	None	Moderate beneficial

References

[1] HM Government. *National Policy Statement for Waste Water: A framework document for planning decisions on nationally significant waste water* (March 2012). Available at: http://www.defra.gov.uk/publications/files/pb13709-waste-water-nps.pdf

[2] Department for Transport (DFT). *Transport Analysis Guidance* (WebTAG) (2003). Available at: http://www.dft.gov.uk/webtag/documents/overview/unit1.2.php

[3] The Council Directive 91/271/EEC concerning urban waste-water treatment. *The Urban Waste Water Treatment Directive* (May, 1991). Available at: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31991L0271:EN:NOT

[4] Environment Agency. *River Basin Management Plan, Thames River Basin District* (2009)

[5] The United Kingdom Technical Advisory Group (UKTAG) to the WFD. Available at: *http://www.wfduk.org/*

[6] Environment Agency (2009). See citation above.

[7] Environment Agency (2009). See citation above.

[8] HR Wallingford (report prepared for the Environment Agency). *Thames Estuary 2100, Morphological changes in the Thames Estuary, Technical Note EP6.8, The development of an historical sediment budget* (2006)

[9] Lane, C, Surman-Lee, S, Sellwood, J and Lee, JV. *The Thames Recreational Users Study Final Report.* (2007)

[10] Lane et al. See citation above.

[11] The Council Directive 91/271/EEC of 21 May 1991 concerning urban waste-water treatment. See citation above.

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.24**

Volume 24: Greenwich Pumping Station site assessment

Section 15: Water resources - flood risk

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Environmental Statement

Volume 24: Greenwich Pumping Station 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 Greenwich Pumping Station 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 24 Greenwich Pumping Station 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 24 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 the Greenwich Pumping Station site would form an integral part of the Thames Tideway Tunnel project and so would help achieve the project-wide sustainability benefits outlined in the *Sustainability Statement*. Given the project-wide sustainability benefits, the proposed development is considered to satisfy part a) of the Exception Test.

15.1.13 The proposed development at Greenwich Pumping Station would be located on previously developed land, therefore satisfying 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 and the development would not lead to an 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 The construction elements of the proposed development relevant to flood risk include:

a. The Greenwich Pumping Station combined sewer overflow (CSO) would be intercepted and the Greenwich connection tunnel would be constructed. The Greenwich connection tunnel would be driven from Greenwich Pumping Station to the main tunnel. Underground interception and valve chambers, a connection culvert and CSO drop shaft would also be constructed as part of the CSO interceptions. The interception chamber would be located upstream of the Greenwich Pumping Station, immediately to the north-west of the pumping station.

b. No works are proposed to the flood defences adjacent to the Greenwich Pumping Station site.

c. The Low Level Sewers No. 1 and 2 and East Greenwich Relief Sewer would be protected during construction. Two foul sewers (457mm) immediately south of the proposed interception chamber would also be protected during construction. Foul and surface water drains of diameter 100 -150mm at the location of the proposed interception chamber would be demolished and replaced as part of the permanent works. The East Greenwich combined Sewer would be diverted to the East Greenwich Relief Sewer.

Code of Construction Practice

15.2.3 Appropriate guidance regarding flood defence construction and emergency planning are included in the *Code of Construction Practice (CoCP)*. The *CoCP* is provided in Vol 1 Appendix A. It contains general requirements (Part A), and site specific requirements for this site (Part B).

15.2.4 The *CoCP* (Section 8) states that no temporary living accommodation would be permitted onsite and that an evacuation route and safe refuge would 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 (Great Britain, 1879)[2].

Operation

15.2.6 The permanent elements at the Greenwich Pumping Station site relevant to flood risk would include:

a. The two branches of the Southern Low Level Sewer No. 1, the Southern Low Level Sewer No. 2, the East Greenwich Relief Sewer and East Greenwich Sewer would be intercepted, and flows diverted to the main tunnel by the Greenwich connection tunnel.

[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.

b. Surface water run-off from the site would be discharged directly into the tidal Creek without attenuation. A brown roof would be installed on the CSO drop shaft area.

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 FRA screening exercise that identified relevant potential flood sources and pathways. The tidal and fluvial assessments have been based on Environment Agency (EA) 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)[3] 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 Section 15).

Tidal flood risk to the proposed development

Level of risk based on the flood zones

15.3.5 The Greenwich Pumping Station site is situated on the eastern bank of the tidal Deptford Creek stretch of the River Ravensbourne. The EA Flood Map identifies the site as lying mostly within Flood Zone 3, with the exception of a small area to the south, along Greenwich High Street, which is located within Flood Zone 2. The floodplain is associated with the Deptford Creek which is tidally linked to the River Thames. The location of the site in relation to the flood zones is shown in Vol 24 Figure 15.3.1 (see separate volume of figures).

15.3.6 Further detail on tidal flood risk has been obtained from the EA Thames Embayment Modelling (Halcrow, 2011)[4]. This has provided tidal flood levels for the Deptford Creek in the 1 in 200 year (0.5% Annual Exceedance Probability [AEP][ii]) and 1 in 1000 year (0.1% AEP) present day undefended scenario, with an operational Thames Barrier. Results from this study indicate that the majority of the site is located within Flood Zone 3a.

[ii] A flood with a 0.5% Annual Exceedance Probability (AEP) has a one in 200 year probability of occurring in a given year. A flood with a 0.1% AEP has a one in 1000 year probability of occurring in a given year.

15.3.7 As the site is located mostly within Flood Zone 3a, the risk from tidal flooding is therefore considered to be high (see methodology in Vol 2 Section 15).

Existing tidal defences

15.3.8 A raised flood defence wall is aligned along the western boundary of the site along the eastern bank of Deptford Creek.

15.3.9 The EA has stated that the statutory flood defence level relevant to the Greenwich Pumping Station site is 5.23m Above Ordinance Datum (AOD). The National Flood and Coastal Defence Database (NFCDD)[5] crest level of the flood defences near the site at Greenwich Pumping Station is between 5.23m AOD and 5.70mAOD.

15.3.10 Condition surveys of flood defences carried out by the EA in December 2010-Feburary 2011 (EA, 2012)[6] state that the defences are in good condition (Grade 2), with some defences in fair condition (Grade 3).

15.3.11 The site is defended from tidal flooding to the statutory level, but floodwaters could inundate the site 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. The site is therefore at residual risk from tidal flooding.

15.3.12 The Strategic Flood Risk Assessment (SFRA) for the Royal Borough (RB) of Greenwich (JBA Consulting, 2011)[7] quantifies 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 Greenwich Pumping Station site is designated in the SFRA as an area of predominantly no or low (Defra and EA, 2006)[8] hazard[iii]. As such, this risk is not considered likely to compromise the long term operational function of the main tunnel.

Tidal flood level modelling

15.3.13 The most extreme flood risk scenario that could affect the site would be a combination of a high tide with a storm surge in the Thames Estuary. This scenario, assuming the Thames Barrier is operational, is the EA's 'design flood' event, a hypothetical flood event representing a specific likelihood of occurrence, in this case the 1 in 200 year (0.5% AEP) flood event.

15.3.14 The EA Thames Tidal Defences Joint Probability Extreme Water Level Study (EA, 2008)[9] provides modelled tidal flood levels for the 1 in 200 year (0.5% AEP) flood event for specific locations (model node locations) within the tidal reaches of the River Thames (tidal Thames).

15.3.15 Vol 24 Table 15.3.1 presents the modelled tidal levels from this study for model node 2.42 which is the most relevant (i.e. closest) to the site. It should be noted that the water levels are expected to decrease in the future due to an amended Thames Barrier closure rule which would be

[iii] Designated using a combination of distance from the defence as flood depth and velocity as per the Defra publication 'Flood Risks to People Phase Two Draft8'

applied in the future (see Vol 2 Section 15) and so the 2005 scenario produces the highest water level.

15.3.16 Vol 24 Table 15.3.1 identifies that the existing defence levels at the site are above the extreme tidal flood level; therefore the site is protected from tidal flooding to the statutory level.

Vol 24 Table 15.3.1 Flood risk – modelled water levels

Return period	Flood level (mAOD)	Statutory flood defence level (mAOD)
0.5% AEP (2005)	4.83	5.23
0.5% AEP (2107)	4.83	

15.3.17 The Thames Embayment Modelling has provided tidal flood levels for the Deptford Creek in the 0.5% AEP and 0.1% AEP present day undefended scenario, with an operational Thames Barrier. The modelled tidal flood level for the location on Deptford Creek closest to the Greenwich Pumping Station site are shown in Vol 24 Table 15.3.1

Vol 24 Table 15.3.2 Flood risk – Thames Embayment Modelling water levels

Return period	Flood level (mAOD)	Statutory flood defence level (mAOD)
0.5% AEP(present day)	4.83	5.23
0.1% AEP (present day)	4.86	

15.3.18 Vol 24 Table 15.3.2 shows that the site is defended up to and above the 0.1% AEP event.

Tidal risk from the proposed development

15.3.19 Following construction of the proposed development there are no proposed changes to the flood defences of the tidal Thames or the Deptford Creek that protect the site. The risk of tidal flooding would remain a residual risk, due to the defended nature of the site. As the site is mostly located in Flood Zone 3a, the flood risk from this source is therefore considered to remain high.

Flood defence integrity

15.3.20 The tunnel excavation process using tunnel boring machines (TBMs) and other construction methods, has the potential to create differential settlement (that is a gradual downward movement of foundations due to compression of soil which can lead to damage if settlement is uneven), which could affect the level of some of the existing flood defences. In addition to that, the shaft construction process has also the potential to affect the flood defences at the site. The proposed Greenwich connection tunnel route runs from Greenwich Pumping Station to the main tunnel at Chambers Wharf and would pass underneath the existing Thames tidal defences which form the banks of Deptford Creek, immediately to the east of the site and therefore has the potential to affect the defences.

15.3.21 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. .

15.3.22 A potential settlement of 19mm is estimated to occur across the river walls at the site (based on information provided by Thames Water). The flood defence levels following settlement is estimated to range from 5.23mAOD to 5.70mAOD. As such, the river walls at the site would remain at or above the statutory flood defence level of 5.23mAOD.

15.3.23 An initial assessment of the effect of construction activities on the structural integrity of flood defences to at the 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, and tie-rod stress increase.

Loss of volume from the tideway

15.3.24 The presence of temporary and permanent structures within the foreshore has the potential to reduce the availability of flood storage within the tidal 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.

15.3.25 The Greenwich Pumping Station site is not located on the banks of the River Thames but is still within the tidal influence of the River Thames at Deptford Creek. Therefore a consideration has been made regarding the implications of the project on water levels within the Tideway and the implications for flood defence freeboard at the Greenwich Pumping Station site.

15.3.26 The Greenwich Pumping Station site is located within the reach of Tower to Charlton in the tidal and fluvial modelling study. The modelling identifies that for this reach the potential maximum decrease in peak water level is 0.002m during the temporary works scenario reducing to 0.001m during the permanent scenario. The modelling also identifies a potential maximum increase of 0.014m in peak water level during the temporary works scenario reducing to 0.005m during the permanent scenario. As identified in para. 15.3.9, the flood defences at this site are above the statutory flood defence level and when compared to the 1 in 200 year tidal level for the year 2107 would provide 0.4-0.87m in freeboard. These predicted changes in water level and therefore freeboard are not considered to reduce flood protection at this site below design standard requirements and are therefore not deemed significant.

15.3.27 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.

Scour management

15.3.28 The *Thames Estuary 2100 (TE2100) Plan (*EA, 2012)[10] includes an assessment of the River Ravensbourne. The TE2100 Plan states that accretion of the river bed is occurring at Greenwich. As no works are planned within the foreshore, no assessment of scour has been carried out at the Greenwich Pumping Station site.

Fluvial flood risk to the proposed development

Level of risk based on the flood zones

15.3.29 This site is situated approximately 600m south from the River Thames. At this location, both fluvial and tidal inputs from the tidal Thames 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 (see methodology in Vol 2 Section 15). As the majority of the site is located within Flood Zone 3a, the fluvial flood risk associated with the tidal Thames is considered to be high.

15.3.30 The site is situated to the east of the tidal stretch of the Ravensbourne River (known as Deptford Creek).

Fluvial flood defences

15.3.31 According to the information contained within the National Flood and Coastal Defence Database[11] (NFCDD) the fluvial reach of the River Ravensbourne upstream of the Greenwich Pumping Station site is defended to the 0.1% AEP standard as detailed in the following paragraphs.

Fluvial flood level modelling

15.3.32 The EA has provided flood levels derived from fluvial modelling on the fluvial extents of the River Ravensbourne. The tidal limit of the Deptford Creek ends at Deptford Bridge, where the Deptford Church Street and A2 (Blackheath Road) cross the river i.e. upstream of the site, which, means that flood risk at the site is predominantly tidal. However, the results of a fluvial modelling carried out for the EA in 2009 (Halcrow, 2009[12]) show that an overland pathway exists from the fluvial extent of the River Ravensbourne to the site should the defences be breached.

15.3.33 The fluvial flood levels at the closest node to the Greenwich Pumping Station site (approximately 350m to the south west) are:

a. 4.89mAOD for the 1% AEP event, inclusive of climate change

b. 5.07mAOD for the 0.1% AEP event.

15.3.34 Flood mapping has been provided by the EA as shown in Vol 24 Figure 15.3.2 (see separate volume of figures). This figure shows that, in the event of a breach in the flood defences, the site would not be inundated during the 1% AEP inclusive of climate change event but would be flooded during the 0.1% AEP event to a depth of approximately 2m by a flow path moving in a northerly direction from the River Ravensbourne towards the River Thames.

15.3.35 As the fluvial reach of the River Ravensbourne is defended to the 0.1% AEP standard, flood risk to the site from fluvial sources is therefore residual. A flow path does exist which would create flooding from breach of defences upstream during an event equal to or in excess of 0.1% AEP. This residual risk is not considered however to compromise the long term operational function of the tunnel.

15.3.36 The fluvial flood risk associated with the River Ravensbourne is therefore medium as the site is located within Flood Zone 2 (see methodology in Vol 2 Section 15).

Fluvial flood risk from the proposed development

15.3.37 The development would be located within the defended floodplain of the tidal Deptford Creek, therefore the impact of the proposed development elsewhere is not applicable for this site and has not been assessed further.

Surface water flood risk to the proposed development

15.3.38 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.

15.3.39 JFLOW[iv] pluvial modelling undertaken for the RB of Greenwich SFRA shows the surface water flooding extent associated with a 1 in 100 year (1% AEP) plus climate change rainfall event. The modelled results indicate that parts of the site could potentially have flood depths of 0.3 – 0.6m.

15.3.40 The site slopes gently from the south to the north with levels between 5.11mAOD to 5.5mAOD along Greenwich High Road and approximately 3.0mAOD to the north of the site. The site is predominantly surrounded by areas of hardstanding. Norman Road, to the east of the site, slopes from the south to the north decreasing from approximately 4.37mAOD at Norman House to approximately 3.73mAOD where the rail line passes over the road. There is a potential for water to enter the site, flowing along the access road within the site to a low point of 3.0mAOD where the CSO drop shaft would be constructed.

15.3.41 There is also a potential for water to enter the site from Greenwich High Road to the south and flow along the road network within the site. The level of Greenwich High Road is approximately 5.4mAOD outside the Greenwich Pumping Station site entrance. Any water entering the site from the point is likely to be initially constrained within the roads in the south of the site where the low point is approximately 3.41mAOD.

[iv] JFLOW hydraulic modelling forms the basis of the EA flood zones mapping

15.3.42 As there is the potential for surface water to flow towards the site, and potential flood depths of up to 0.6m have been identified, the flood risk from this source is considered to be medium (see methodology in Vol 2 Section 15).

Surface water flood risk from the proposed development

15.3.43 A full assessment of the likely significant effects on surface water from the Greenwich Pumping Station site is provided in Section 14 of this volume.

15.3.44 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 the Waste Water NPS, runoff rates following the proposed development should not be greater than the existing (pre-development) rates. The *London Plan 2011* (GLA, 2011)[13] and the *Mayor's Water Strategy* (GLA, 2011)[14] set out a preferred standard of attenuation to the greenfield runoff rate and an essential standard of 50% attenuation of the peak surface water runoff rate at peak times. These standards are however not applicable if surface water runoff from a development discharge directly into the tidal Thames due to its large capacity.

15.3.45 The site is currently a mix of permeable areas and hardstanding areas. Surface water is currently drained to a series of surface water sewers across the site.

15.3.46 There would be no increase in the total impermeable area as a result of the proposed works.

15.3.47 As detailed in Section 8 of this volume, there is a history of contamination on site which precludes the use of infiltration SuDS.

15.3.48 The Deptford Creek is tidally linked to the tidal Thames and therefore, surface water would be discharged directly into the Deptford Creek. Due to the tidal nature of the receiving watercourse, surface water runoff rates to the Creek would not increase surface water flood risk to the site or surrounding area and would therefore not require attenuation prior to discharge. Furthermore, a brown roof is proposed on the CSO drop shaft area, which would help manage surface water runoff as well as provide wider sustainability benefits.

15.3.49 In the event of a storm coinciding with a high tide event, surface water drainage from the site may be restricted and would need to be stored on site. If necessary, on-site storage would therefore be provided to manage flood risk in the event of tide-locking of the surface water outfall.

15.3.50 Following the implementation of the above drainage measures the risk of surface water flooding from the proposed development to the surrounding area is considered to remain unchanged.

Groundwater flood risk to the proposed development

15.3.51 Groundwater flooding occurs where groundwater levels rise above ground surface levels.

15.3.52 The upper aquifer at this site is within the river terrace deposits. The Upnor Formation, Thanet Sands and Seaford Chalk form the lower aquifer. There is expected to be hydraulic continuity between the upper and lower aquifers at the Greenwich Pumping Station site.

15.3.53 Groundwater levels in the river terrace deposits have been recorded in the proximity to the site at borehole PR1023(U) and are on average approximately 5.54 – 6.37m below ground level (bgl). Groundwater levels in the Thanet Sands have been recorded at boreholes PR1023(L) and SR1018D (also in the proximity to the site) and are on average at approximately 15.4m bgl.

15.3.54 Flood risk from groundwater is considered to be low as groundwater levels in the upper aquifer are unlikely to reach the ground surface at the site given their depth (see methodology in Vol 2 Section 15).

Groundwater flood risk from the proposed development

15.3.55 An assessment of the likely significant effects on groundwater at the Greenwich Pumping Station site is provided in Section 13 of this volume.

15.3.56 The CSO drop shaft would pass through made ground, alluvium, river terrace deposits (upper aquifer), Lambeth Group and Thanet Sands and the Seaford Chalk (lower aquifer).

15.3.57 Internal dewatering (inside the diaphragm wall) is anticipated during the construction phase to manage the water levels within the shaft and manage the risk of flooding to the drop shaft from this source. The internal dewatering would yield considerably smaller quantities of groundwater in comparison to external dewatering. Groundwater brought to the surface as a result of dewatering during construction would be extracted and following any necessary treatment and subject to EA approval would discharged directly to Deptford Creek.

15.3.58 The presence of the CSO drop shaft may create a physical barrier and disrupt groundwater flows. It is estimated that the groundwater levels would rise by approximately 0.3m. The predicted rise in water levels would result in increased hydraulic pressure within the confined unit rather than an increase of the water table. As a result, it is considered that there is no subsequent increase in flood risk and the risk from groundwater flooding would remain as low.

Sewers flood risk to the proposed development

15.3.59 Sewer flooding arises when the sewer network is exceeded or a problem arises such as a blockage or fracture.

15.3.60 There are a number of combined sewers cross the Greenwich Pumping Station site and surrounding area. Most of the trunk and a few local sewers are routed through the pumping station and are of variable size, from 381mm to 3200mm. Other trunk and local sewers pass through the site but are not pumped.

15.3.61 The Low Level Sewers No. 1 (Main Line) and 2 (2134mm and 2438mm diameter respectively) and Low Level Sewer No. 1 (Bermondsey Branch) (2134mm diameter) combined sewers enter the Greenwich Pumping

Station site from the west and connect to a single penstock chamber. The East Greenwich Sewer (914 x 1372mm) runs approximately westwards before connecting to the Low Level Sewer No. 2. The 381mm diameter Ravensbourne Sewer connects to the East Greenwich Sewer north-east of the site. A number of manholes are located along this sewer. All of the above sewers, and the East Greenwich Relief Sewer (1905mm diameter), which runs westwards, flow into a chamber immediately north-west of Greenwich Pumping Station.

15.3.62 The Effra Branch Sewer (Main Line) flows approximately north-east towards Greenwich pumping station as four 1067mm diameter sewers. The sewer enters a chamber towards the south of the Greenwich Pumping Station site and subsequently continues eastward as two 1067mm sewers. The Greenwich Road Sewer connects to the Effra Branch Sewer at a junction chamber and then continues eastward as a 3048mm diameter sewer. A 3200mm diameter discharge culvert flows in a north-west to south-east direction from Greenwich Pumping Station and connects to the Effra Branch Sewer which in turn connects to the Southern Outfall Sewer towards Crossness Sewage Treatment Works. During non-storm conditions sewage from Greenwich Pumping Station would be directed along the 3200mm diameter discharge culvert to the Southern Outfall Sewer.

15.3.63 If Crossness Sewage Treatment Works is at capacity, sewage is directed along the northern discharge culvert from Greenwich Pumping Station to the Deptford Overflow Sewer (3505mm diameter) and then to the tidal Thames. The two discharge culverts from the Greenwich Pumping Station merge in a penstock chamber, allowing control of the discharge from each culvert. The penstocks are located upstream of the connection between the discharge culvert and the Effra Branch Sewer.

15.3.64 The capacity of the Deptford Overflow Sewer is unlikely to be exceeded as it is designed to discharge via the outfall and therefore the flood risk from this sewer is low. However, the Deptford Overflow Sewer could be surcharged during high tides. Sewer flooding upstream of Greenwich Pumping Station along the Low Level Sewer No. 1, Low Level Sewer No. 2, East Greenwich Sewer and East Greenwich Relief Sewer is primarily a factor of the capacity of the pumps at Greenwich Pumping Station. Should the capacity of the combined sewers or Greenwich Pumping Station be exceeded, sewage could surcharge through gullies and manholes along the reach of the sewers.

15.3.65 Flooding records (Thames Water, 2012)[15] show that there have been no sewer flooding incidents recorded within 200m of the site since 1990.

15.3.66 Ground levels at the site slope gently south to north. Pathways would be primarily restricted to roads in and surrounding the site.

15.3.67 As there are no records of flooding from sewers and pathways are limited at the site the flood risk from this source is considered to be low.

Sewers flood risk from the proposed development

15.3.68 Following construction of the proposed development, sewage flows would be intercepted immediately upstream (north-west) of the Greenwich Pumping Station. An interception chamber would be constructed adjacent to the penstock chamber upstream of Greenwich Pumping Station. The interception chamber would contain a weir which would take flow off the penstock chamber. The weir would allow the pumps in Greenwich Pumping Station to work at the same time as the main tunnel.

15.3.69 At present sewage discharges from the Deptford Overflow Sewer to the tidal Thames when the capacity of the Crossness sewage treatment works or the Southern Outfall Sewer is exceeded. Following construction, when the Crossness treatment works or Southern Outflow Sewer are at capacity, all flows normally pumped by Greenwich Pumping Station would be diverted to the main tunnel.

15.3.70 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[v]. Further detail is provided in Vol 3 Section 15.

15.3.71 There would only be a restriction on sewage flows entering the main tunnel should the tunnel become full or unavailable. In this situation, and when Crossness sewage treatment works is also at capacity, sewage flows would be diverted to the tidal Thames via the Deptford Overflow sewer. The design would ensure that there is no increase in flood risk compared to the existing scenario.

15.3.72 Following the construction of the proposed development the risk of flooding from this source would be unchanged and therefore would remain as low.

Artificial source flood risk to and from the proposed development

15.3.73 There are no nearby artificial flood sources e.g. canals, reservoirs, which could lead to flooding of the site.

15.3.74 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 Measures have been incorporated into the design of the proposed development to ensure that the risk of flooding to and from the site and surrounding areas is not increased during the construction and operational phases. These measures are described below although many have already been referred to in the preceding section.

[v] The base case scenario comprises the sewage treatment works (STW) Improvements and Lee Tunnel in 2020s.

Tidal and fluvial

Construction

Flood defences

15.4.2 No works are proposed to the local flood defences as part of the construction works at the Greenwich Pumping Station site. However, as discussed in para. 15.3.20, the proposed Greenwich connection tunnel would pass beneath the existing Thames Tidal defences which form the banks of Deptford Creek to the west of the site and has the potential to affect the integrity of the defences.

15.4.3 Defence assets, which are considered to be at risk of settlement, would be monitored during construction and if their level is reduced they would be built back up to their existing levels. With this strategy in place no adverse residual effects of settlement are anticipated.

15.4.4 Design options to preserve the structural stability of the flood defences at this site would be dependent on the contractor's construction methodology. Potential options for the flood defences at this site may include strengthening works and/or the construction of load relieving platforms.

15.4.5 Appropriate Protective Provisions would be agreed with the EA for any works within 16m of the flood defences on the landward side and within the river. These would be agreed prior to any works within 16m of the flood defences being commenced.

Emergency plan

15.4.6 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

15.4.7 The permanent operational areas would be protected from flooding by the existing Thames tidal flood defences which form the banks of Deptford Creek to the west of the site. As detailed in paras. 15.5.8 and 15.3.12 and in Vol 3 Section 15, the residual risk to the site is not considered to compromise the long term operational function of the main tunnel and as such, no further measures are required.

Emergency plan

15.4.8 The site is an existing operational site, therefore the existing emergency plan regarding staff procedures in the event of a flood would be adhered to.

Surface water

Construction

15.4.9 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. These design measures 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

Surface water management

15.4.10 As discussed in para. 15.3.44 surface water run-off from the site would be discharged directly into the tidal Creek without attenuation. A brown roof would be installed on the CSO drop shaft area.

Groundwater

Construction and operation

15.4.11 Groundwater monitoring is proposed during construction and operation. Groundwater resulting from the dewatering during construction would be pumped to the Deptford Creek following treatment and subject to the EA approval. Further measures regarding dewatering and groundwater levels are described in Section 13 of this volume.

Sewer

Construction

15.4.12 The Low Level Sewers No. 1(Main Lines and Bermondsey Branch) and 2 and East Greenwich Relief Sewer would be protected during construction. Two foul sewers (457mm) immediately south of the proposed interception chamber would also be protected during construction. Foul and surface water drains of diameter 100 -150mm at the location of the proposed interception chamber would be demolished and replaced as part of the permanent works. The East Greenwich Sewer would be diverted.

Operation

15.4.13 Following construction, when the Crossness treatment works or the Southern Outfall Sewer are at capacity, all flows normally pumped by Greenwich Pumping Station would be diverted to the drop shaft.

15.4.14 Should the tunnel become full or unavailable when Crossness sewage treatment works is at capacity, sewage flows would be diverted to the tidal Thames via the Deptford Overflow sewer, ensuring no increase in flood risk compared to the existing scenario.

15.5 Assessment summary

Flood risk

15.5.1 The Greenwich Pumping Station site is located in Flood Zone 3a associated with the tidal influence of the River Thames in Deptford Creek. There are no proposals to carry out works to the existing local flood defences.

15.5.2 The site is also located within the fluvial floodplain of the River Ravensbourne and is protected from fluvial flooding up to and above the 0.1% AEP event.

15.5.3 In line with 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 an increase in flood risk on the surrounding areas. Therefore, no significant flood risk effects are likely.

15.5.4 Vol 24 Table 15.5.1 provides a summary of the findings of the FRA undertaken for this site.

Residual risk to the development

15.5.5 The residual risk to the site is the risk that remains after all design measures have been incorporated.

15.5.6 The site is at residual risk of tidal and fluvial flooding in the event of a breach in the tidal Thames and River Ravensbourne flood defence walls or overtopping of the tidal Thames defence wall as a result of a failure of the Thames Barrier.

15.5.7 In the very unlikely event of a mechanical failure at the pumping station, there is potential for sewage to back up within the system and surcharge through manholes and gullies.

15.5.8 It is considered that the consequence of a breach or failure of flood defences or a failure of the pumping station, 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

15.5.9 Following the incorporation of the design measures outlined in Vol 24 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 24 Table 15.5.1 Flood risk – FRA summary

Source	Pathway	Current flood risk to the proposed development	Design measures (construction and operation)	Flood risk from the proposed development (post design measures)	Flood risk to the proposed development post design measures
Tidal	Breach/overtopping of tidal Thames flood defences	High (but residual only)	Flood Defence height maintained. 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 residual only) (No change for existing situation)
Fluvial	Breach/overtopping of tidal Thames flood defences	High (but residual only)	Flood Defence height maintained. Monitoring of flood defence levels and repaired as required to maintain existing crest level	No increase in fluvial flood risk as a result of proposed development.	High (but residual only) (No change from existing situation)
	Breach/overtopping of the River Ravensbourne (Deptford Creek) flood defences	Medium (but residual only)	Flood Defence height maintained.	No increase in fluvial flood risk as a result of proposed development.	Medium (but residual only) (No change from existing situation)
Surface water	Surrounding area	Medium	Surface water discharged directly into tidal Creek.	No increase in surface water flood risk as a result of proposed development.	Medium (No change from existing situation)
Groundwater	Underlying geology and groundwater levels un-restricted pathway	Low	Internal dewatering during construction. Groundwater discharged to Deptford Creek (following	No increase in groundwater flood risk as a result of proposed development.	Low (No change from existing situation)

Source	Pathway	Current flood risk to the proposed development	Design measures (construction and operation)	Flood risk from the proposed development (post design measures)	Flood risk to the proposed development post design measures
			treatment). Monitoring proposed during construction and operation.		
Sewers	Sewer network	Low	Sewers would be protected during construction. All flows currently pumped by Greenwich Pumping Station would be diverted to the main tunnel.	Low	Low (No change from existing situation)
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

[2] Great Britain. *Thames River Protection of Floods Amendment Act 1879* London, The Stationery Office.

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

[4] Halcrow Group Limited. *Thames Embayment Modelling* (June 2011).

[5] Environment Agency. *National Flood and Coastal Defence Database* (October, 2011).

[6] Environment Agency. *Flood defence data* (received January 2012).

[7] JBA Consulting. *LB of Greenwich Strategic Flood Risk Assessment Final Report* (October 2011).

[8] Defra and Environment Agency. *Flood Risk to People, The Flood Risk to People Methodology* (FD2321/TR1) (March 2006).

[9] Environment Agency. Thames *Tidal Defences Joint Probability Extreme Water Levels 2008. Final Modelling Report* (April 2008).

[10] Environment Agency. *Thames Estuary 2100 Plan* (November 2012).

[11] Environment Agency. *National Flood and Coastal Defence Database* (October, 2011).

[12] Halcrow Group Limited. *Ravensbourne Flood Mapping Review* TH660 – Volume 1 Final Modelling Report (October 2009).

[13] Greater London Authority. *The London Plan Spatial Development Strategy for Greater London* (July 2011).

[14] Mayor of London. Greater London Authority. *Securing London's Water Future. The Mayor's Water Strategy* (October 2011).

[15] Thames Water. *Sewer Flooding Records* (received June 2012).

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