Thames Tideway Tunnel
Thames Water Utilities Limited

Development Consent Order

Application Reference Number: WWO10001

Documents for Certification
September 2014

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

Lindsay Speed   Sarah Fairbrother

September 2014

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.02**

Volume 2: Environmental assessment methodology

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

Hard copy available in

Box **16** Folder **A**
January 2013

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

This page is intentionally blank

Thames Tideway Tunnel

Environmental Statement

Volume 2: Environmental assessment methodology

Errata

Section	Paragraph No.	Page No.	Errata / Clarification
Section 7 Historic environment	N/A	N/A	This section should be read in conjunction with the *Settlement Information Paper*, which is included in Volume 1 Appendix C.
Section 9 Noise and vibration	N/A	N/A	This section should be read in conjunction with the Thames Tideway Tunnel compensation programme which includes *the Settlement Information Paper*. These documents are provided in Volume 1 Appendix C and are also reproduced in the *Statement of Reasons* which accompanies the application.
Section 9 Noise and vibration	9.10.1	38	Although not mentioned in the text, regard has also been had of the Government's Noise Policy Statement for England (Defra, 2010). Available online at: http://www.defra.gov.uk/publications/files/pb13750-noise-policy.pdf. It is considered that the *Environmental Statement* proposals for noise mitigation include consideration of what is set out in the Noise Policy Statement for England (Defra, 2010).
Section 10 Socio-economics	N/A	N/A	This section should be read in conjunction with the Thames Tideway Tunnel compensation programme which includes the *Settlement Information Paper*. These documents are provided in Volume 1 Appendix C and are also reproduced in the *Statement of Reasons* which accompanies the application.

Section	Paragraph No.	Page No.	Errata / Clarification
Section 15 Water resources – flood risk	N/A	N/A	This section should be read in conjunction with the *Settlement Information Paper*, which is included in Volume 1 Appendix C.

Thames Tideway Tunnel

Environmental Statement

List of contents

This page is intentionally blank

Thames Tideway Tunnel

Environmental Statement

Volume 2: Environmental assessment methodology

List of contents

Thames Tideway Tunnel

Environmental Statement

Volume 2: Environmental assessment methodology

Sections 1-3

List of contents

Page number

List of plates

Page number

List of tables

Page number

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.02**

Volume 2: Environmental assessment methodology

Section 1: Introduction

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

Hard copy available in

Box **16** Folder **A**
January 2013

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

This page is intentionally blank

1 Introduction

1.1.1 This volume presents the approach and methodology used for the assessment of likely significant environmental effects associated with the Thames Tideway Tunnel project. The purpose of this volume is to describe and explain how the environmental impact assessment (EIA) has been undertaken to provide the necessary context for the subsequent project-wide (Volume 3) and site-specific assessments (Volumes 4 to 27).

1.1.2 Following this introduction, Section 2 of this volume sets out the process by which the EIA has been completed, focusing on key activities, stages and outputs. The methodology has been informed by consultation and engagement with a range of stakeholders, which is described throughout this section and which mirrors the presentation of the section on EIA in the *Consultation Report* which forms part of the application for development consent (the application).

1.1.3 Section 3 focuses on the general approach to the EIA of the Thames Tideway Tunnel project across all environmental topics.

1.1.4 Sections 4 to 15 set out the specific methodologies and any variations used for assessing each of the environmental topics, as follows:

a. Section 4 – Air quality and odour
b. Section 5 – Ecology – aquatic
c. Section 6 – Ecology – terrestrial
d. Section 7 – Historic environment
e. Section 8 – Land quality
f. Section 9 – Noise and vibration
g. Section 10 – Socio-economics
h. Section 11 – Townscape and visual
i. Section 12 – Transport
j. Section 13 – Water resources – groundwater
k. Section 14 – Water resources – surface water
l. Section 15 – Water resources – flood risk. Note, this topic follows a different structure to other environmental topics in line with the approach for flood risk assessment.

1.1.5 Within each topic, the following headings are presented as they relate to the assessment methodology:

a. engagement (including scoping)
b. legislation and guidance
c. baseline data collection, including desk based data, field survey data, receptor identification and sensitivity and base case

d. construction effects, including assessment years, assessment areas, methods and significance criteria

e. operational effects, including assessment years, assessment areas, methods and significance criteria

f. cumulative effects

g. project-wide effects

h. assumptions and limitations

i. mitigation

j. residual effects.

1.1.6 A separate glossary of technical terms and abbreviations is provided alongside this *Environmental Statement*.

1.1.7 Volume 1 Introduction to the Environmental Statement provides more information on the legislative and policy context for the project and the *Environmental Statement*. This *Environmental Statement* has been produced with regard to this and to relevant best practice guidance, including but not limited to the following. In some instances, guidance and legislation has been updated since it was used at the time, such as the *Infrastructure Planning Commission's Advice Note 7*:

a. *Planning Act* 2008[1] (as amended by the Marine and Coastal Access Act 2009 and the Localism Act 2011)

b. *Infrastructure Planning (Environmental Impact Assessment) Regulations 2009*[2] (as amended by the *Infrastructure Planning (Environmental Impact Assessment) (Amendment) Regulations 2012*[3]).

c. *Waste Water National Policy Statement (NPS)* (designated March 2012)[4]

d. *Infrastructure Planning (Waste Water Transfer and Storage) Order 2012*[5]

e. *National Planning Policy Framework*[6]

f. Department of Communities and Local Government (DCLG*) Circular 02/1999 Environmental Impact Assessment*[7]

g. DCLG Circular 01/2006 *Guidance on Changes to the Development Control System*[8]

h. DCLG amended *Circular on Environmental Impact Assessment* (consultation paper, June 2006)[9]

i. DCLG *Environmental Impact Assessment: A guide to good practice and procedures* (consultation paper, June 2006)[10]

j. *Guidance on EIA Scoping* (European Commission, June 2001)[11]

k. Planning Inspectorate, *Advice note 3: EIA notification and consultation,* version 4 (May 2012)[12]

l. Planning Inspectorate, *Advice note 6: Preparation and submission of application documents*, version 5 (June 2012)[13]

m. Planning Inspectorate, *Advice note 7: Environmental Impact Assessment, screening and scoping*, version 3 (April 2012)[14]

n. Planning Inspectorate, *Advice note 9: Using the 'Rochdale Envelope*', version 2 (April 2012)[15]

o. Planning Inspectorate, *Advice note 12: Development with significant transboundary impacts consultation*, version 3 (April 2012)[16]

p. Planning Inspectorate, *Advice note 14: Compiling the consultation report*, version 2 (April 2012)[17]

q. EA *Scoping guidelines for the Environmental Impact Assessment of Projects*, (May 2002)[18]

r. Institute of Environmental Management and Assessment (IEMA), *Guidelines for Environmental Impact Assessment* (2004)[19].

s. European Commission, *Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions* (1999)[20].

1.1.8 Topic specific guidelines are referred to within the topic specific assessment methodology sections (Vol 2 Section 4 to 15).

This page is intentionally blank

Thames Tideway Tunnel
Thames Water Utilities Limited

Thames Water

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.02**

Volume 2: Environmental assessment methodology

Section 2: EIA process, consultation and engagement

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

Hard copy available in

Box **16** Folder **A**
January 2013

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

This page is intentionally blank

2 EIA process, consultation and engagement

2.1 Introduction

2.1.1 The Department of Communities and Local Government (DCLG) defines EIA as “the process for identifying the environmental effects (positive and negative) of proposed developments before development consent is granted. The aim of EIA is to prevent, reduce or offset the significant adverse environmental effects of development proposals, and enhance positive ones. It is a means to ensure that planning decisions are made in the knowledge of the attendant environmental effects and with full engagement of statutory bodies, local and national groups and members of the public” (DCLG, 2006)[21].

2.1.2 EIA is in part a sequential process and in part an iterative process. Vol 2 Plate 2.1.1 illustrates the general sequential EIA process applied to the Thames Tideway Tunnel project linking:

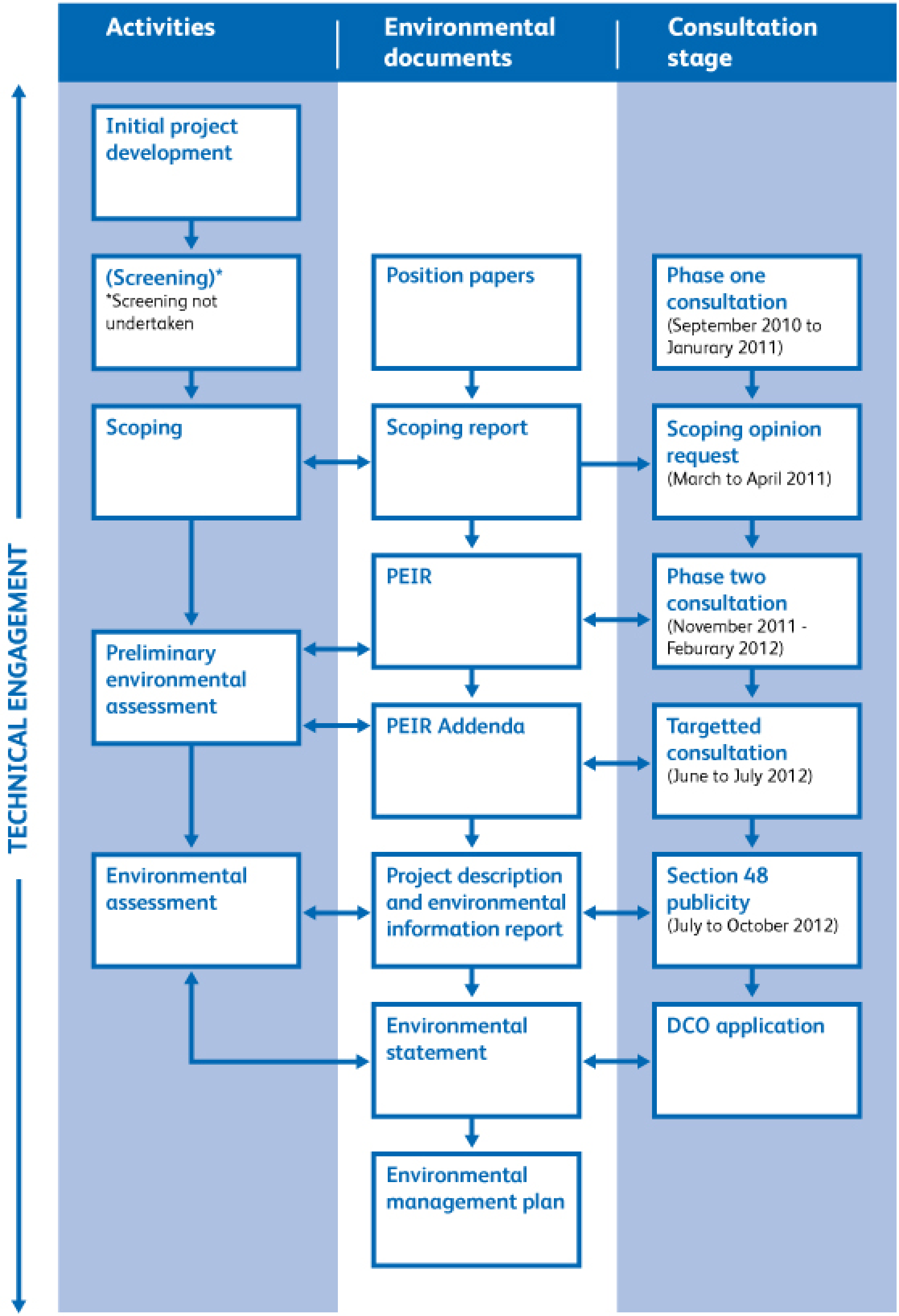
a. stages and activities of the EIA process, eg, scoping

b. outputs of the EIA process, eg, *Scoping Report*

c. consultation phases, eg, phase one, phase two.

2.1.3 Section 3.2 explains more about the iterative nature of the EIA process, focusing on the design and assessment process.

Vol 2 Plate 2.1.1 EIA process for Thames Tideway Tunnel project



2.2 Initial project development

2.2.1 Whilst the EIA process generally begins with screening to determine whether a statutory *Environmental Statement* is required, environmental considerations and the assessment process have been integral to the Thames Tideway Tunnel project from its outset. This reflects the very nature of the project which seeks to improve the environmental conditions of the River Thames and for receptors that depend on it including humans, flora and fauna.

2.2.2 Environmental considerations have been fundamental to the identification of the problem and definition of the Thames Tideway Tunnel project as the proposed solution. This includes input into option definition and assessment work, as reported in the *Final Report on Site Selection Process*.

2.2.3 Further information on the context of the project is provided in Vol 1, in particular sections on the need for the project (Vol 1 Section 1.1), the statutory framework (Vol 1 Section 1.3), proposed development overview (Vol 1 Section 2), and alternatives (Vol 1 Section 3).

2.3 Screening

2.3.1 Vol 1 sets out the statutory framework for the preparation of the Thames Tideway Tunnel project *Environmental Statement*.

2.3.2 Screening is the process used to determine whether a development is likely to have significant effects on the environment and therefore whether an EIA and associated *Environmental Statement* is required.

2.3.3 Given the scale and complexity of the project and the sensitivity of the local environment within which it would be constructed and operated, the proposed development was considered likely to have the potential to give rise to significant effects on the environment. As such, an EIA has been undertaken and a statutory *Environmental Statement* prepared.

2.3.4 No 'screening opinion' was therefore requested from decision makers. Instead, and in anticipation of the project being designated a Nationally Significant Infrastructure Project (NSIP), a letter was sent to the Infrastructure Planning Commission (IPC) (now the Planning Inspectorate) on 9 September 2010 and 2 November 2011 notifying them of the intention to submit an application and an accompanying *Environmental Statement* for the proposed Thames Tideway Tunnel project.

2.3.5 The Thames Tideway Tunnel project is considered to be 'EIA development'. This position is the same, regardless of whether the project is considered under the *Town and Country Planning (Environmental Impact Assessment) (England and Wales) Regulations 1999*[22] (as amended) ('the *1999 EIA Regulations'*) which applied to the project at the time a screening opinion would have been requested, or within the *Planning Act 2008* and the *Infrastructure Planning (Environmental Impact Assessment) Regulations 2009* (as amended) ('the *2009 EIA Regulations*') which apply since 23 June 2012 when the project was designated an NSIP.

2.3.6 The Section 14(3) Order designating the project as an NSIP enables the decision maker to treat anything done before the date on which the Order came into force as having complied with pre-application requirements of the 2008 Act, if it would have complied with those requirements had been done after that date. Thames Water did not consider it necessary to re-issue the Regulation 6(1)(b) of the *2009 EIA Regulations* notice prior to the commencement of post phase two targeted consultation.

2.3.7 By letter dated 9 December 2011, the IPC confirmed that the content and timing of the notifications reflected the relevant statutory requirements.

2.4 Scoping

Introduction

2.4.1 Having determined that an EIA is required, the next stage was scoping. DCLG defines scoping as:

"the process of determining the content and extent of matters to be covered by the EIA and in the resulting *Environmental Statement.* It is a link on the continuum between screening and the subsequent impact assessment " (Department of Communities and Local Government, 2006)[23].

2.4.2 The scope of an *Environmental Statement* is determined in large part by EIA regulations. The *2009 EIA Regulations* state that the *Environmental Statement* must describe the likely significant effects of a project on aspects of the environment. Vol 2 Table 2.4.1 lists those aspects with where they are covered in this *Environmental Statement*.

Vol 2 Table 2.4.1 Aspects of the environment to be covered under 2009 EIA Regulations

Aspects of the environment to be covered under 2009 EIA Regulations	Topic within this Environmental Statement
Population	Townscape and visual; noise and vibration; socio-economics; transport; land quality; historic environment; air quality
Fauna	Ecology – terrestrial; ecology - aquatic
Flora	Ecology – terrestrial; ecology - aquatic
Soil	Land quality
Water	Water resources – groundwater; water resources – surface water; water resources – flood risk
Air	Air quality and odour

Aspects of the environment to be covered under 2009 EIA Regulations	Topic within this Environmental Statement
Climatic factors	Climatic factors in particular climate change and adaptation are covered inherently within each topic. See Volume 1 Section 1.3 for more details.
Material assets* (including architectural and archaeological heritage)	Historic environment and Flood Risk (including settlement damage to structures); note that no other significant effects of settlement would be likely and so have not been assessed.
Landscape	Townscape and visual
Inter-relationships between the above factors.	Inter-relationships between topics are considered inherently within topics as opposed to in the cumulative effects assessment. For example, the amenity assessment presented in the socio-economics assessment involves the consideration of potential air quality, construction dust, noise, vibration (human response) and visual impacts. See para. 3.8.4 for more information.

** Natural resources have been considered as part of the EIA. The project would make use of natural resources such as concrete and steel and Thames Water would seek to promote the sustainable use of such resources. Further information is provided in Section 1.5 of Volume 3 of the ES and in the Sustainability Statement.*

2.4.3 The scope has also been determined through voluntary, early and ongoing engagement with stakeholders and more formally through the publication of an EIA *Scoping Report* (Thames Water , 2011)[24] and request for scoping opinions, in line with good practice.

2.4.4 Stakeholder engagement occurred prior to and throughout the EIA scoping process, and regular feedback from the scoping exercise into the design was a critical component ensuring the appropriate incorporation of environmental design measures during the early stages of the project.

Early engagement, position papers and phase one consultation

2.4.5 In the latter part of 2010 and early 2011, engagement with statutory and non-statutory stakeholders took place through an extensive programme of site meetings, briefing meetings and presentations, technical working groups and workshops. This included potentially directly affected local authorities, Port of London Authority, Transport for London, Environment Agency (EA), Natural England and English Heritage.

2.4.6 For some topics – including air quality and odour, noise and vibration, townscape and visual, aquatic ecology, terrestrial ecology, historic environment and land quality – position papers setting out information about the EIA and proposed assessment methodologies were circulated primarily to potentially directly affected local planning authorities for comment but also to other agencies such as Natural England where relevant. These are included in Vol 2 Appendix B.1, C.1, D.1, E.1, F.1, G.1, I.1. Responses received in respect of the EIA position papers informed the EIA process and *Scoping Report* and led to methodologies being amended and clarified where appropriate. The updated methodologies are those that are presented in Vol 2 Sections 4 to 15, which also take into account feedback from subsequent stages of the EIA process such as the *Preliminary environmental information report (PEIR)* (Thames Water, 2011)[25].

2.4.7 In parallel to this, phase one consultation on the proposed development took place between 13 September 2010 until 14 January 2011. The purpose of phase one consultation was to ensure all consultees had the chance to understand and influence the Thames Tideway Tunnel project proposals at an early stage. This included the need, proposed tunnel route, and site-specific issues. The information upon which phase one was based included environmental information, for example in the form of site specific project information papers (eg, Acton Storm Tanks) and project information papers (eg, managing construction). Responses the consultation are summarised in the *Main Report on Phase 1 Consultation* (Thames Water, 2011)[26]. Responses have helped inform route selection, site selection and design and mitigation and in doing so have influenced the EIA process as it is described here. Phase one consultation comments are included where relevant for topics and for sites although the subsequent step of scoping provides more detailed site and topic specific comments from stakeholders.

Scoping Report

Purpose

2.4.8 Although not a statutory requirement, there is a well established process under legislation and practice for seeking agreement on the scope of the EIA through the request for a ‘scoping opinion’ from the decision makers. This approach has been followed by the Thames Tideway Tunnel project in order to:

a. Identify main environmental considerations at an early stage in the EIA process

b. Define the scope of the *Environmental Statement*, focusing on key considerations during construction and operation

c. Identify the environmental information requirements to inform the *Environmental Statement* and the methods for collecting this information (eg, desk based studies, surveys etc).

d. Define the methodology for assessing the likely significant effects on the environment

e. Foster long-term relations with stakeholders and to improve the efficiency of the decision making process

2.4.9 Importantly, the scoping process has been used to 'scope out' those matters that do not require further consideration as they are unlikely to lead to significant effects on the environment during construction or operation and to allow the assessment to focus on effects which are likely to be significant, both beneficial and adverse.

Statutory context and approach

2.4.10 The Thames Tideway Tunnel project *Scoping Report* was submitted in March 2011 in support of a request for scoping opinions under Section 10 of the *1999 EIA Regulations* (as amended) (the regulations applicable at the time) to each potentially directly affected local authority within which the project is located. At the time, local authorities represented the decision makers.

2.4.11 Through this process, the potentially directly affected local authorities consulted with a wide range of consultees to inform their response and in order to assist in this process, the *Scoping Report* was also issued directly to such consultees. Appendix A.1 of this volume sets out all the bodies consulted on the *Scoping Report*.

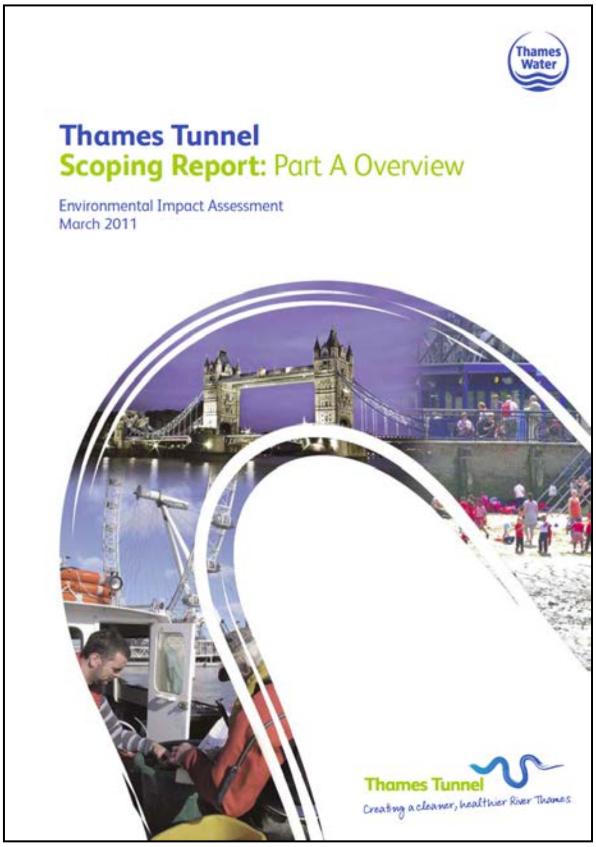
2.4.12 It was anticipated, however, that the project would be designated an Nationally Significant Infrastructure Project (NSIP) and would therefore be determined by the IPC (now the Planning Inspectorate) in accordance with the *Planning Act 2008* and its associated EIA legislation, the *2009 EIA Regulations*. Consequently, an approach was adopted which shadowed the *2009 EIA Regulations* alongside the *1999 EIA Regulations*, ensuring both sets of requirements were met. In this respect, the IPC was also consulted on the scope of the *Environmental Statement* during the scoping stage, as if regulation 8 of the *2009 EIA Regulations* formally applied to the project.

2.4.13 The consultation period lasted between 7 March and 18 April 2011, a period of 42 days in line with the *2009 EIA Regulations* and longer than the standard length of five weeks of the *1999 EIA Regulations*.

2.4.14 The *Scoping Report* identified the likely significant effects on the environment of the proposed Thames Tideway Tunnel project as presented during the phase one consultation process (the phase one preferred scheme) which ran between 13 September 2010 until 14 January 2011. The report was published before the comments from the phase one consultation had been collated and reviewed, and therefore did not incorporate any changes to the scheme resulting from this consultation stage.

2.4.15 The *Scoping Report* described the phase one preferred scheme, the proposed methodology for assessing project-wide and site specific likely significant environmental effects as well as setting out the proposed structure of the *Environmental Statement*. No mitigation measures were assumed when determining which topics to scope out during construction and operation.

Vol 2 Plate 2.4.1 Scoping Report



Scoping opinions received

2.4.16 The *Scoping Report* was issued to the consultation bodies listed in Appendix A.1 of this volume, which also indicates whether or not responses have been received. Further details on the nature of the consultation responses received are included in Appendix A.2 of this volume. Full scoping opinions are included in Vol 2 Appendix P.

2.4.17 In summary, of the 158 requests for scoping opinions made, 39 responded, half of which generally had no detailed comments, whilst the other half provided detailed comments. Stakeholders that provided detailed responses mostly comprised of local authorities and stakeholders such as English Heritage, Transport for London, the Greater London Authority and the EA. The IPC provided feedback on the *Scoping Report* through Section 51 advice (see Vol 2 Appendix A.3).

2.4.18 The detailed responses relating to the EIA process fell within two categories: those that were generally supportive of the suggested approach to the EIA and those that suggested changes or additions to the approach. For example, stakeholders requested monitoring of dust prior to and during the construction phase and that setting should be included in the historic environment assessment. In addition to these two categories, a small number of respondents provided comments on third party infrastructure related issues.

2.4.19 Topic specific scoping opinion comments received from stakeholders, and how these have been addressed through the EIA process and the

Environmental Statement, are summarised in the topic assessment methodologies presented in Sections 4 to 15 and Vol 2 Appendix B.1 to M.1.

2.4.20 Where site-specific comments have been received they are included in the engagement sections of the site assessments set out in Volumes 4 to 27.

2.4.21 There were a number of general, cross-topic comments received from consultees. These comprised:

a. The EIA should analyse the impacts against existing plans, policies and advice

b. The EIA should give consideration to best practice guidance

c. Alternatives should be identified and assessed, and reasons should be provided for the selection of the preferred solution

d. The EIA should assess all likely significant effects, including those from construction, operation and decommissioning

e. The EIA should identify opportunities for mitigation and improvement of environmental conditions

2.4.22 These general, cross-topic comments have been considered and addressed throughout the EIA process.

Scoping approach for new sites

2.4.23 The *Scoping Report* described the 'preferred scheme' for the project at the phase one consultation stage. However, it was recognised that the project could change as a result of considering the responses to consultation (for example, the location of preferred sites or the nature of activities on them could change), scheme development and/or other changes in circumstances. It was noted that this could result in other sites emerging as potential sites, and that Thames Water would have to consider, on a case by case basis, engaging with statutory stakeholders in order to determine the ongoing adequacy of issues scoped in and scoped out.

2.4.24 Since the *Scoping Report* was issued, a number of sites identified as 'preferred sites' at the scoping stage, have been replaced by alternative sites and design changes have been made, as described in Section 3 on alternatives in Vol 1.

2.4.25 As recognised in the *Scoping Report*, there is considerable similarity between certain sites in terms of the topics scoped in and out, and the proposed assessment methodology. For example, similar issues and approach for foreshore sites, for inland sites, and for combined sewer overflow (CSO) and main tunnel drive sites. As a result, it was concluded that the scope of the assessment for those sites which were new or where design changes were made would be likely to be the same as for those already identified. Therefore further scoping opinions were not sought, although ongoing engagement with statutory stakeholders throughout the EIA process regularly reviewed the scope of the assessment to be adopted at all sites. This also applies to the *PEIR* and *PEIR Addenda* (see para. 2.5.14) which were subject to phase two consultation and targeted consultation respectively and where stakeholders has the opportunity to comment on the scoping approach adopted for new sites.

Summary of scope

2.4.26 A summary of topics scoped in and out of the assessment both during construction and operation is provided in the Vol 2 Table 2.4.2 below. This follows publication of the *Scoping Report*, consideration of scoping opinions and ongoing technical engagement and represents the scope of this *Environmental Statement*.

2.4.27 Overall, the outcomes of scoping have been to agree the scope and approach to topic assessments, appropriate modelling, data collection, and facilitate better communication of the project to stakeholders. Scoping and continuing engagement have both been fundamental to the approach to the EIA.

2.4.28 The outcome of scoping consultation and ongoing engagement summarised by topic has been considered in the development of the EIA approach, and each EIA topic methodology presented in Vol 2 Sections 4 to 15.

Vol 2 Table 2.4.2 Topics scoped in and out of the Environmental Statement

Topic	Commentary on issues	Scoped in for construction?	Scoped in for operation?
Air quality and odour	Potential effects could include local air quality impacts during construction (eg, plant and vehicle emissions) and operation (eg, potential occasional odour releases from vent stacks). A separate *Air Management Plan* has been prepared as part of the application.	✓	✓
Ecology – aquatic	Potential effects could include temporary and/or permanent land take impacts on foreshore and in-river habitats. Beneficial operational effects could include improved water quality with consequent benefits to the aquatic ecosystem (both locally and throughout the tidal reaches of the River Thames [tidal Thames]).	✓	✓
Ecology – terrestrial	Potential construction effects could include land take impacts on some areas of habitat. Impacts on protected species are also possible. Following further consideration since the publication	✓	×

Topic	Commentary on issues	Scoped in for construction?	Scoped in for operation?
	of the *Scoping Report* and receipt of scoping opinions of the operational maintenance requirements, there are not anticipated to be significant operational effects.		
Electro-magnetic radiation (EMR)	The tunnel boring machine requires an electrical supply for electric motors and other support equipment that generates local electromagnetic field. The equipment is required to comply with international standards to prevent any potential electromagnetic interference. No construction or operational electromagnetic radiation effects are anticipated and the topic is therefore scoped out.	×	×
Historic environment	The project could affect archaeological deposits and built heritage, especially during construction but also in relation to physical impact and the setting of built heritage assets during operation (as a consequence of the new above ground infrastructure).	✓	✓
Land quality	Potential construction effects due to mobilisation of any existing contamination at some sites. Following further consideration since the publication of the *Scoping Report* and receipt of scoping opinions, and through discussions with the EA, there are not anticipated to be significant operational effects.	✓	×
Lighting	Potential effects from construction and operational lighting could arise and are considered within relevant sections of the *Environmental Statement* including terrestrial and aquatic ecology and townscape and visual.	✓	✓

Topic	Commentary on issues	Scoped in for construction?	Scoped in for operation?
Microclimate	Potential sunlight/daylight effects associated with sizes and locations of ventilation structures and proximity to existing residential properties has been considered as part of the Daylight/Sunlight Assessment submitted as part of this application. No potential impacts have been identified from proposed operational structures. No potential wind effects related to construction are anticipated. It is not envisaged that there would be wind effects during operation that would require assessment. This topic is therefore scoped out.	✗	✗
Noise and vibration	Potential effects during construction due to noise impacts upon nearby sensitive receptors. Potential operational effects are likely to be limited to any perceptible noise from ventilation equipment, exhausting of air and the movement of material down the CSO drop shafts and main tunnel shafts.	✓	✓
	There could be effects associated with vibration during construction as a result of construction activities. No operational effects are anticipated but commentary level assessment is provided.	✓	✓
Socio-economics	Likely significant construction effects could include loss of amenity and some adverse impacts on community receptors; beneficial effects are likely to include job creation and increased spend in local communities close to construction sites. Operational beneficial effects could include aesthetic, health and amenity benefits for river users.	✓	✓
Townscape and visual	Potential effects could arise during construction as a result of the	✓	✓

Topic	Commentary on issues	Scoped in for construction?	Scoped in for operation?
impacts	impacts of large plant, equipment and jetties. Above ground operational infrastructure impacts could have an effect on townscape and visual elements.		
Transport	Potential environmental effects arising during construction could include transport delays and severance of existing access routes (including footpaths and cycleways). During the operational phase, operational traffic movements would be minor (associated with occasional inspections) and operational effects can therefore be scoped out. A commentary level assessment is nevertheless provided on operational matters.	✓	✓
Water resources – groundwater	Potential effects could arise due to the potential groundwater quality impacts associated with construction and possibly operation, plus groundwater resource impacts arising from local construction dewatering.	✓	✓
Water resources – surface	Likely significant effects could arise due to the construction impacts associated with any potential accidental spills. Beneficial significant operational effects could arise due to the impacts of improved water quality (both locally and throughout the tidal Thames).	✓	✓
Water resources – flood risk	There is the potential for sites to lie within an area at risk of flooding. In addition the development of a site may increase flood risk to the site and/or surrounding areas, for example due to increased surface water runoff. Construction and operation phases are therefore scoped in.	✓	✓

Topic	Commentary on issues	Scoped in for construction?	Scoped in for operation?
Excavated material	The excavation, storage and movement of material and waste have the potential to result in significant environmental effects. This may be both on site where it is excavated, produced or stockpiled and offsite where it is beneficially reused, processed, or disposed of. The excavation, storage and movement of excavated material and waste generated on site have been considered within each of the individual topics: transport; noise and vibration; air quality; land quality; historic environment; townscape and socio-economics within each site volume, rather than as an individual waste topic. The *Waste management plan* (see Vol 3 Appendix A.3), *Excavated material and waste strategy* (see Vol 3 Appendix A.3) and *Excavated materials options assessment* (see Vol 3 Appendix A.4) included in this application further address waste issues.	✓	✓

✓Scoped in.
✗ Scoped out.

Decommissioning

2.4.29 Although the design life of the main tunnel infrastructure is set at 120 years the decommissioning of the project infrastructure is not anticipated (similar to the continuing use of the Victorian interception system built in the 1860s). Repair and replacement of certain parts of the infrastructure would occur during the life of the project. As such, decommissioning effects have not been assessed.

Transboundary effects

2.4.30 Regulation 24 of the *2009 EIA Regulations* requires the Planning Inspectorate to notify other European Economic Area (EEA) States and publicise an application for development consent if it is of the view that the proposed development is likely to have significant effects on the environment of another EEA Member State, and where relevant to consult with the EEA State affected.

2.4.31 To assist the Planning Inspectorate's own examination of transboundary effects and possible decision to consult with neighbouring EEA states, an assessment has been made on transboundary effects which is summarised below. Further detail is provided in Vol 2 Appendix O, which has been structured against the transboundary screening matrix set out in the *PINS Advice note 12*[27].

2.4.32 The approximate distance by sea to the nearest town of Calais in France is 159km by sea or 137km by air. Similarly, the approximate distance by sea to the Exclusive Economic Zones (EEZ) of France is 137km. The distance is greater still to towns and the EEZ of Belgium and Netherlands.

2.4.33 Having analysed the potential environmental impacts and effects of the project, it is not anticipated that there would be any likely significant transboundary effects for the reasons outlined below:

a. Whilst the project would require large quantities of natural resources, some of which may be sourced from abroad, it is not anticipated that the impacts of the project from the use of resources would lead to significant effects that extend to neighbouring EEA States. The use of natural resources is considered in Section 1.5 of Volume 3 and in the *Sustainability Statement*.

b. It is not anticipated that the impacts of the project from waste, pollution, and nuisance would extend to neighbouring EEA States.

c. Even though the spatial scope of assessment varies from topic to topic, the furthest extent of effects is generally not expected to extend beyond levels such as:

   i the tidal Thames, in the case of aquatic ecology

   ii the road network within west, central and east London within the Greater London boundary, in the case of transport

   iii at a Greater London or Thames Estuary level for employment, amenity and recreation, in the case of socio-economics.

   iv road corridors which have significant number of construction lorries being generated by the project such as the A2 corridor from Greenwich to the Kent disposal site, in the case of transport

   v for other topics, effects are likely to be even more localised. For historic environment, for example, with the exception of effects from ground movement, the assessment area for physical effects on above ground or buried heritage assets is defined by the site boundary

   vi These assessment areas have been subject to consultation with stakeholders, in particular during consultation on the *Scoping Report*.

d. The *Habitats Regulations Assessment: No Significant Effects* concludes that the Thames Tideway Tunnel project is not likely to have a significant effect on any European site, either within the UK or in Europe.

2.4.34 No consultation has taken place with neighbouring EEA states on the basis that it is not anticipated that there would be any significant transboundary environmental effects. Therefore, transboundary effects have not been considered further.

2.5 Preliminary environmental information assessment

PEIR

2.5.1 As mentioned in para. 2.4.12, the project shadowed the 2009 EIA Regulations before it was formally designated as an NSIP. Regulation 10 of the *2009 EIA Regulations* requires the applicant to prepare a consultation statement under Section 47 (duty to consult) of the *Planning Act 2008* setting out:

a. whether the development for which the applicant proposes to make an application for the granting of development consent is EIA development

b. if that development is EIA development, how the applicant intends to publicise and consult on the preliminary environmental information.

2.5.2 'Preliminary environmental information' is defined in Regulation 2 as information referred to in Part 1 of Schedule 4 of the *2009 EIA Regulations* which:

a. has been compiled by the applicant

b. is reasonably required to assess the environmental effects of the development (and associated development).

2.5.3 Thames Water prepared a *Preliminary environmental information report (PEIR)*[28]. This was produced in accordance with the Thames Tideway Tunnel project *Community consultation strategy* (*CCS*) and a *Statement of community consultation* (*SoCC*). The latter was prepared in September 2010, and updated in Autumn 2011. The PEIR took into account guidance and regulations including the Town and Country Planning Act 1990, the 1999 EIA Regulations (as amended) and the 2008 Act.

2.5.4 The *PEIR* was included as part of the phase two public consultation exercise, which ran from 4 November 2011 to 10 February 2012.

2.5.5 The regular programme of meetings and briefing sessions with local authorities and stakeholders such as TfL were used as opportunities to inform stakeholders of the process of preparing the *PEIR*, its content and the process for submission of feedback.

2.5.6 The *PEIR* provided preliminary environmental information on the anticipated development, including construction sites, tunnels, operational infrastructure, and other associated development. The *PEIR* provided a snap shot in time during the EIA process to facilitate effective consultation.

2.5.7 Comments made on the project including the *PEIR* during phase two were captured in a *Main report on phase two consultation*. The *Main report on phase two consultation* stated that further detailed responses to *PEIR* and environmental comments would be provided in this *Environmental Statement*. These are covered in the following sections:

a. Topic methodological comments and responses to these on the *PEIR* and EIA are captured in Vol 2 Sections 4.2 to 15.2 and Vol 2 Appendix B.1 to M.1.

b. Site-specific comments and responses to these on the *PEIR* and EIA are captured in engagement sections within Volumes 4 to 27.

2.5.8 There were few general methodological comments on the *PEIR* and *Environmental Statement* other than a comment on Strategic Environmental Assessment. These comments and responses to them are dealt with in Appendix A.4.

2.5.9 Because the *PEIR* set out preliminary findings of the assessment and design development up to a point in time, the assessment information was not final or complete. This *Environmental Statement* completes the assessment including:

a. Further baseline data collection

b. Further refinement and detail on the impacts and effects

c. Further development of design, embedded measures and mitigation for residual effect

d. Cumulative effects assessment. See Section 3.8 for more information.

e. Final assessments

2.5.10 The *PEIR* included 'other work sites' information on West Putney, Savoy Street, Shad Thames Pumping Station and Bekesbourne Street. The former two sites were included in the *PEIR* but do not form part of this application as the required works are very minor in nature, involving minor modifications to the existing sewer network.

2.5.11 Shad Thames Pumping Station is presented as Vol 19 of this *Environmental Statement*, whilst Bekesbourne Street is presented in Vol 27.

PEIR Addenda

2.5.12 In the Thames Tideway Tunnel project's *Statement of community consultation*, Thames Water committed to consider whether any changes proposed as a result of phase two consultation would affect the nature of the comments received during this period and where appropriate to undertake targeted consultation.

2.5.13 As a result of the feedback received during phase two consultation, some changes were introduced to the proposals at four sites, which triggered a targeted consultation that ran for 28 days from 6 June to 4 July 2012. Part of this process has involved consulting on addenda to *PEIR* volumes for four sites:

a. Barn Elms – where changes were proposed to the access road.

b. Putney Embankment Foreshore – where changes were proposed to the location and layout of the temporary works and permanent design.

c. Albert Embankment Foreshore – where alternative access was proposed via a temporary road between Tintagel House and Camelford House.

d. Victoria Embankment Foreshore – where changes were proposed to the location and layout of the temporary works and permanent design.

2.5.14 The purpose of the *PEIR Addenda* was to describe the potential changes at sites and to identify whether these would have the potential to give rise to likely significant environmental effects not identified in the assessment presented at phase two consultation or which would be materially different.

2.5.15 Further comments received as a result of this targeted consultation have been taken into account as part of the preparation of the application and this *Environmental Statement*. Comments focused mainly on the design proposals and are captured in engagement sections within Volumes 4 to 27. There were no general methodological or scoping comments from stakeholders.

2.6 Section 48: Project description and environmental information

2.6.1 At the same time as the targeted consultation took place and feedback was considered, the project was designated as an NSIP. In line with the requirements of Section 48 of the *Planning Act 2008*, the application for development consent for the project was publicised. This ran between 16 July and 5 October 2012.

2.6.2 The information published at that stage included a *Section 48: Project description and environmental information report*. That document did not comprise an *Environmental Statement* for the purposes of the *EIA Regulations*, as there is no requirement to provide this as part of the Section 48 publicity material. It described the environmental effects of the proposed development and was voluntarily published at that stage and intended to assist an understanding of the nature and location of the proposed development.

2.7 Environmental Statement

2.7.1 This *Environmental Statement* represents the culmination of several stages of work described above. It provides an assessment of the Thames Tideway Tunnel project described in the application. It represents a reflection of a move towards a parameters approach as described in Vol 1 and Vol 2 Section 3.6.

2.7.2 Schedule 4 Part 2 of the *2009 EIA Regulations* details the minimum information required for inclusion within the *Environmental Statement*. In addition, the *Environmental Statement* must include any relevant additional information as is reasonably required to assess the environmental effects of the project, as specified in Schedule 4 Part 1 of the *2009 EIA Regulations*.

2.7.3 The content and structure of this *Environmental Statement* (including its non-technical summary) is described in detail in Vol 1. Details of where the information requirements are addressed within the *Environmental Statement* are provided in Vol 1 Table 1.3.1.

2.8 Environmental management

2.8.1 The environmental commitments made in this *Environmental Statement* will be delivered through incorporation into all design and construction activities. Design and construction will be undertaken by contractors who will be contractually required to comply with the commitments within the Environmental Statement. Thames Water will develop and implement robust management arrangements to ensure that contractors deliver a high standard of environmental and sustainability performance. This will be supported by ongoing communications with stakeholders including statutory authorities

2.9 Summary of engagement

2.9.1 Vol 2 Table 2.9.1 summarises engagement undertaken during the EIA process in terms of forms of engagement, purpose, frequency and stakeholders that attended.

Vol 2 Table 2.9.1 Summary of engagement

Form of engagement	Purpose	Frequency	Stakeholders that attended
General meetings eg, design / planning / environment	Meetings to discuss elements of the design / planning proposals as well as environmental impact based on feedback from stakeholders and industry experts.	Approximately bi-monthly or as required during planning/design stages	London Borough (LB) of Lambeth, Royal Borough (RB) of Kensington and Chelsea, LB of Southwark, LB of Newham, Westminster City Council, LB of Hammersmith and Fulham, LB of Ealing, LB of Richmond upon Thames, Transport for London, LB of Wandsworth, City of London Corporation, LB of Tower Hamlets, LB of Lewisham, RB of Greenwich, English Heritage, Battersea Society, West London River group
CoCP meeting	Meeting to discuss the proposed *Code of Construction Practice* Part A and phase two consultation comments as well as specific mitigation measures applicable to each site as covered in the *CoCP* Part B. The *CoCP* Parts A and B are provided in Vol 1 Appendix A.	One to one meetings between January and February 2012	LB of Lambeth, RB of Kensington and Chelsea, LB of Southwark, LB of Newham, Westminster City Council, LB of Hammersmith and Fulham, LB of Ealing, LB of Richmond upon Thames, Transport for London , Greater London Authority, LB of Wandsworth, City of London Corporation, LB of Tower Hamlets, LB of Lewisham , RB of Greenwich, LB of Hounslow
Biodiversity working groups	Meeting with local biodiversity stakeholders to provide an update on ecological components of the Thames Tideway Tunnel project.	Approximately every 4-6 months since 2010	LB Lewisham, LB Hammersmith and Fulham, LB Richmond, LB of Lambeth, Westminster City Council, LB of Ealing, Greater London Authority, LB of Wandsworth, LB of Tower Hamlets, RB of Greenwich, Environment Agency, London Wildlife Trust, Natural England, River Thames Society, Salmon & Trout Association, Thames River Restoration Trust, Thames21, Port of London Authority,

Form of engagement	Purpose	Frequency	Stakeholders that attended
			RSPB, MMO, All London Green Grid
Transport design development workshops	Meetings to discuss potential transport impacts of the Thames Tideway Tunnel project on a site by site basis as well as potential mitigation measures and traffic access route options.	Series of meetings: May 2011, June-July 2011; June 2012 and November 2012	LB of Lambeth, RB of Kensington and Chelsea, LB of Southwark, LB of Newham, Westminster City Council, LB of Hammersmith and Fulham LB of Ealing, LB of Richmond upon Thames, Transport for London
Environmental Health Officer (EHO) forums	Consultation with local authority Environmental Health Officers on a range of project topics, including the development of the Thames Tideway Tunnel project *CoCP*.	Approximately quarterly, since November 2010	LB of Lambeth, RB of Kensington and Chelsea, LB of Southwark, LB of Newham, Westminster City Council, LB of Hammersmith and Fulham, LB of Ealing, LB of Richmond upon Thames, Transport for London, Greater London Authority, LB of Wandsworth, City of London Corporation, LB of Tower Hamlets, LB of Lewisham, RB of Greenwich
Flood risk forum	Meeting to discuss the scope of the flood risk assessment including the results of flood risk modelling and brief local authorities about ongoing assessment work.	June 2011	EA, Local Authorities
Flood risk technical working group	Meetings to discuss the scope of flood risk assessments including the results of flood risk modelling.	Approximately bi-annually	EA
Surface water technical working group	Meeting to discuss the scope of the surface water assessment including water quality modelling being undertaken by Thames Water.	Approximately bi-annually	EA

Form of engagement	Purpose	Frequency	Stakeholders that attended
Waste technical working group	Meeting to discuss the approach to the project waste strategy and the appraisal of excavated material options.	Approximately bi-annually	EA
Heritage and archaeology working group	Meetings to discuss the impact of construction and operation of the Thames Tideway Tunnel project to establish heritage assets at proposed sites.	Approximately quarterly	English Heritage
Tower Hamlets working group	Meeting to discuss project overview and resident concerns about the King Edward Memorial Park site.	Approximately bi-annually	LB of Tower Hamlets Save KEMP
Putney working group	Meeting to discuss the proposed site at Barn Elms, as well as the Putney Embankment Foreshore site.	Approximately bi-annually	EA The Putney Society Stop the Shaft - Putney & Barnes Thames 21
Groundwater and land quality technical working group	Meetings to discuss the groundwater and land quality, including assessment methodologies used in the *Environmental Statement* and subsequent issues	Various since March 2011	EA
Health impact assessment workshops	Workshops to discuss scope, content and progress of the HIA	September 2011 and June 2012	Attendees at EHO forum meetings plus Greenwich NHS, NHS London Health Urban Development Unit, London Port Health Authority, Southwark NHS, Newham NHS

Thames Tideway Tunnel
Thames Water Utilities Limited

Thames Water

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.02**

Volume 2: Environmental assessment methodology

Section 3: General EIA methodology

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

Hard copy available in

Box **16** Folder **A**
January 2013

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

3 General EIA methodology

3.1 Introduction

3.1.1 This section presents the general assessment methodology used for the assessment of likely significant environmental effects associated with the Thames Tideway Tunnel project. This methodology applies to all topics and to both project-wide (Vol 3) and site assessments (Volumes 4 to 27) unless stated otherwise.

3.2 Approach to assessment, design, mitigation and monitoring

3.2.1 As an overarching principle, Thames Water has actively sought to prevent/avoid, reduce or offset adverse environmental effects and consider beneficial effects. This has been done through the design and assessment process and would continue going forward as part of the delivery of the project.

3.2.2 In practice, this has involved a collaborative and partly sequential, partly iterative approach to identifying potentially adverse impacts and effects and determining appropriate design measures to address these. For example, the effects of noise upon residential receptors have been identified by noise specialists as a result of demolition and construction activities. These impacts and effects, in particular significant ones, have then been regularly communicated to the project team for attention, principally through regular design workshops, alongside suggested measures to prevent/avoid or reduce them. For example, noise specialists have proposed measures such as enclosures or taller site hoarding as a means of reducing noise.

3.2.3 In a small number of cases, certain suggested measures have been put forward which potentially conflict with one another; for example, taller site hoarding may reduce noise effects but may introduce adverse visual amenity effects. Where this is the case, a decision has been made by Thames Water on which suggested measure to incorporate and how to balance such potentially conflicting considerations.

3.2.4 In reaching a decision on which measures to incorporate, environmental considerations have then been reviewed alongside other factors such as design feasibility, planning and land ownership. Once these measures have been incorporated they have been termed ‘embedded measures’ or ‘environmental design measures’.

3.2.5 Embedded measures relevant to the construction phase are contained primarily in the *CoCP* and are referenced throughout this *Environmental Statement*. For the operational phase, such embedded measures and commitments are represented primarily in the *Design Principles* document which is also referenced in this *Environmental Statement*. The

Environmental Statement assesses effects with embedded measures in place.

3.2.6 Where significant adverse effects are identified (after considering these embedded measures), further ‘mitigation measures’ have been proposed. Further details on the definition of significance is provided in Section 3.7. Generally, mitigation measures have only been recommended for significant adverse effects, unless stated and explained otherwise (for example, see Section 7 Historic environment).

3.2.7 An assessment of effects has been made with mitigation measures in place and this is termed the ‘residual effects assessment’. In some cases, mitigation measures may not be possible or appropriate, meaning that there are residual significant effects.

3.2.8 On the whole, the general approach to the project has been such that most measures for preventing/avoiding or reducing effects have been embedded into the project, meaning that few mitigation measures are required.

3.2.9 For some topics and in some instances, it is not possible to prevent/avoid or reduce certain effects. For example, the loss of foreshore habitat due to permanent landtake is noted as an adverse effect for aquatic ecology. No measures have been deemed available or appropriate to prevent/avoid or reduce this effect. However, Thames Water proposes to address this by providing habitat or suitable ecological improvement off-site. These measures have not been described or assessed as mitigation because they do not prevent/avoid or reduce the effect at a site where habitat has been lost. These measures can, however, be deemed to offset/compensate these effects. Mitigation is thus defined for the purposes of this *Environmental Statement* as measures to avoid/prevent or reduce effects which are not embedded into the project.

3.2.10 Mitigation does not include measures to offset/compensate. The exception is in the case of financial compensation. This is considered to form part of the mitigation measures where a business can demonstrate it has suffered a financial loss as a result of the project. In this case, compensation payments can be made to mitigate the loss.

3.2.11 For those topics where offsetting/compensation measures are applicable, this is presented for project-wide in Volume 3 and site assessments in Volumes 4 to 27.

3.2.12 Volume 1 Appendix C contains the documents which comprise the Thames Tideway Tunnel compensation programme which are as follows:

a. Exceptional hardship procedure

b. Non-statutory mitigation compensation scheme

c. Non-statutory disturbance compensation scheme

d. Noise insulation and temporary re-housing policy

e. Settlement information paper

3.2.13 The above documents are also reproduced in the *Statement of Reasons*.

3.2.14 It is recognised that due to the project's potential construction working hours, its duration, and the potential for construction sites to be close to properties, there may be disturbance in certain locations which may give rise to financial loss or damage to property. It may be possible to recover this loss or damage by claiming compensation from the Thames Tideway Tunnel project.

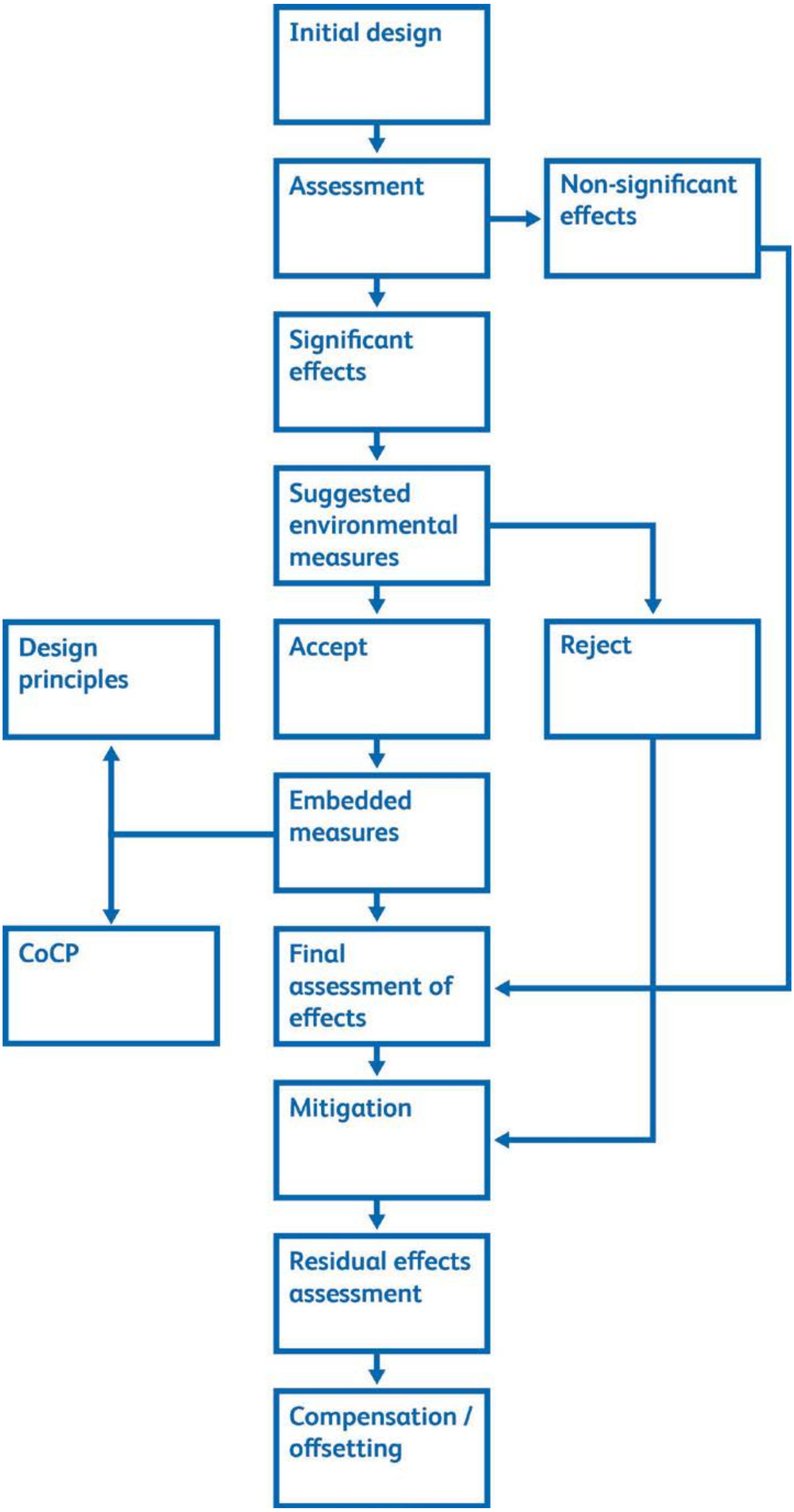
3.2.15 While the Thames Tideway Tunnel team will comply with environmental and other statutory regulations at all times, the compensation programme addresses particularly sensitive areas where claims may fall outside the current legal compensation regime.

3.2.16 Where appropriate, measures proposed as part of the compensation programme have been used in the EIA as a means of mitigating or off-setting potential adverse environmental effects. Details of this are contained in the relevant topic assessments, primarily the noise and vibration and socio-economics assessment, in the site assessment volumes.

3.2.17 Where topic-specific monitoring is required, this is also identified by topic, with details on the purpose, location and timing of monitoring.

3.2.18 Vol 2 Plate 3.2.1 summarises the environmental design process for the Thames Tideway Tunnel project.

Vol 2 Plate 3.2.1 Environmental design process for the Thames Tideway Tunnel project



Level of detail in the application and assessment

3.2.19 As described in Section 2.4 of the *Planning Statement*, in its application for development consent, Thames Water has sought to achieve an appropriate balance between certainty and flexibility. Approval is therefore sought through the application for development consent for a scheme framed within defined parameters and design principles, and secured where appropriate through DCO requirements (see Section 1.3 of Volume 1).

3.2.20 Where necessary, details of matters such as external appearance of above-ground structures and buildings will be submitted for future approval through DCO requirements.

3.2.21 The works for which approval is sought are shown on a series of plans for each site, contained in the *Book of Plans*. The following categories are used to indicate the level of detail shown on the plans for each of the construction sites:

a. 'For approval': the detail included on the plan has been submitted for approval. The development would be carried out in accordance with the details shown on the plan.

b. 'Indicative': the detail shown on the plan is not for approval. The plan indicates and commits to the way in which the development would be arranged. However, details such as materials, planting schedules etc. remain to be determined. The final detail of the works will be submitted and approved under the requirements for the site in the DCO and must be in accordance with the indicative layout and the design principles that are included in the application for development consent.

c. 'Illustrative': the detail shown on the plan is not for approval. The plan illustrates one way in which the development or an element of it might be arranged in accordance with design principles that will be developed for the site in question, but it is not a commitment to arrange the development as illustrated. The final layout of the development, or the relevant part thereof, will be submitted for approval under the requirements for the site in the application for development consent. These details may differ from the illustrative layout in the application. The layout submitted for approval under the requirement must, however, be in accordance with the works plan, site works parameter plan, and design principles for that site.

d. 'For information'. These plans show existing details on sites (for example the existing site features and layout). They are not for approval as part of the application for development consent but are provided to inform consideration the application for development consent.

3.2.22 The *Environmental Statement* reflects the above approach whereby account has been taken of the status of plans and information available in making an assessment and providing input to design and mitigation. This approach has also used a 'reasonable worst case' approach where relevant, described further in Section 3.4.

3.3 Baseline

3.3.1 Prior to undertaking the impact assessments for each topic the current environmental conditions have been identified. This is known as identifying the baseline.

3.3.2 A wide range of information about the existing environment has been obtained from observations made on-site, field surveys, information provided by stakeholders and desk based information. This allows the existing environmental resources present to be identified and evaluated.

3.3.3 Sufficient information and data have been obtained from the various sources to allow the assessment undertaken to be robust. Where gaps or limitations exist in the information gathered, this is reported in relevant sections in the project-wide (Vol 3) and site-specific assessments (Volumes 4 to 27).

3.3.4 Data provided has been used under licence where applicable, including GIS information[i].

3.4 Base case and assessment cases

3.4.1 The EIA considers the likely significant environmental effects associated with the Thames Tideway Tunnel project and does this against a future baseline. Whilst existing baseline data form a ‘current baseline’, it is important within the EIA to consider how the environment is likely to change, in any event, in the absence of the project. For example, traffic levels typically increase year-on-year. This ‘future baseline’ is described as the ‘base case’ in the rest of this assessment. It represents a ‘do nothing’ or ‘without the Thames Tideway Tunnel project’ scenario.

3.4.2 The Thames Tideway Tunnel project has been assessed against the base case, both for construction and operation, for particular assessment years. The ‘with Thames Tideway Tunnel project’ is also known as the ‘development case’.

3.4.3 Different base cases can be described for a particular assessment years, during both construction and operational phases. This is described in more detail below in Section 3.5.

3.4.4 The base case has not only been derived from assessing likely changes in the environment but also by considering the presence and effects of newly built, partially built (if built out in phases) or fully operational development. This is consistent with *PINS Advice note 9* (Planning Inspectorate, 2012)[29] which specifies that the base case should include built and operational development. This has allowed sensitive receptors associated with these base case developments to be considered within the topic assessments as appropriate.

---

[i] Data used includes data derived from: 1:50000 scale BGS Digital Data under license 2009/003 British Geological Survey © NERC; data from Landmark Information Group; data under copyright from SeaZone Solutions Limited, 2005, 032011.014; data under Ordnance Survey copyright.

3.4.5 For example, in 2012 there may not be any residential receptors within 50m of a proposed Thames Tideway Tunnel project site. However, a residential development may be built and fully occupied by the time construction starts at the Thames Tideway Tunnel project site in 2018. The presence of this new residential development could introduce additional sensitive receptors (eg, new residents) which could potentially be affected by the Thames Tideway Tunnel project (eg, by construction traffic and noise). It is therefore appropriate that this new development be factored into the base case so that an accurate and representative assessment of effects is made.

3.4.6 The identification of new development proposals relevant to the base case has been carried out during the course of the assessment and in particular during a review of relevant schemes as part of the cumulative effects assessment. Further details on the latter are provided in Section 3.8.

3.4.7 Not all developments are necessarily relevant to each topic base case. In the example above, the new residential development may be relevant to for example, air quality and noise, but not to terrestrial ecology as the development would neither remove nor introduce additional terrestrial ecology receptors.

3.4.8 The base case has been predicted as accurately as possible to ensure the robustness of the subsequent assessment. Predictive modelling, historical information and trends and data projections have all been used to support base case identification.

Use of reasonable worst case scenario

3.4.9 Given the parameters of the proposed development, there is potential for variation in the associated range of impacts and effects. This *Environmental Statement* assesses a reasonable worst case scenario for adverse effects. This means that within a range of possible assumptions about an activity, the *Environmental Statement* reports upon the higher level of *likely* impacts and effects. It is *reasonable* in the sense that where impacts and effects are considered unlikely, they are not reported because they do not reflect likely impacts and effects. This use of a reasonable worst case scenario allows for a robust assessment.

3.4.10 This is in line with Planning Inspectorate guidance on the ‘Rochdale envelope’ (Planning Inspectorate, 2012)[30]. It applies both in terms of temporal scope, as described in Section 3.5, and in terms of spatial scope, as described in Section 3.6.

3.4.11 An example of the application of the reasonable worst case scenario can be found in Section 3.6.

3.5 Temporal scope and assessment years

Introduction

3.5.1 In order to undertake a robust EIA which considers the likely significant effects of the proposed development, it is necessary to establish when, during the construction and operational periods, those significant effects are most likely to happen. The temporal scope of the assessment varies from topic to topic. For some topics it is considered appropriate to use fixed assessment years eg, Site Year 1 of construction/ Year 1 of operation, whilst for others the assessment has been undertaken throughout longer periods of time eg, entire construction phase. The approach to establishing the temporal scope for the assessment of construction and operational effects is described in more detailed below and generally follows the higher level of impacts and effects approach as described in Section 3.4.

3.5.2 Vol 2 Table 3.5.1 below provides a summary of the temporal scope and assessment years used by the individual topics for their assessment of site-specific and project-wide likely significant effects.

3.5.3 The relation between the assessment years and the proposed project's construction programme is based on the construction logistic strategy.

3.5.4 The development of the Thames Tideway Tunnel project programme has been informed by the need to expedite the prompt delivery of a solution to the UK's breach of the UWWTD in respect of the Beckton and Crossness catchments. The ES reflects the likely significant environmental effects associated with the proposed works, having regard to the six year programme over which they are likely to be carried out. The ES also factors in the likely timescales for other development projects which affect the base case and the cumulative effects assessment. Identifying these other development projects has involved a systematic review of planning application documentation and discussion and review by stakeholders including the relevant local authorities and developers. The environmental effects identified within the ES are therefore considered 'likely' on the basis of the best available information on these programmes. It is recognised however, that there may be potential variations or changes to the Thames Tideway Tunnel project programme and other developments' timeframes due to a range of factors (eg, a delay in receiving planning approval or time savings provided by contractors through further detail design). For this reason and as a sensitivity test, each environmental topic therefore also considers whether there would be likely to be any material changes to the assessment findings, in the event of a programme delay. Whilst the actual nature and extent of any programme delay that might occur cannot be predicted with certainty, it is considered appropriate to select a representative period so as to enable a realistic, informative and proportionate sensitivity test to be undertaken. A representative period of approximately one year has therefore been used for the purposes of the sensitivity test. Whilst the possibility of delays in excess of one year cannot of course be entirely excluded, in view of the robustness of the programme that has been established, and the considerable urgency in delivering the proposed development, significantly longer delays are not considered sufficiently likely to require specific assessment.

Assessment year: construction

3.5.5 The assessment year (or years) for the assessment of construction effects varies between topics and from site to site. For certain topics (eg, terrestrial ecology), impacts could arise at any point throughout the construction period and therefore effects have been assessed for the entire construction phase.

3.5.6 For other topics, it is more appropriate to undertake the assessment at the time when the higher level of effects would occur eg, the assessment of transport effects is undertaken for the peak construction year when vehicle movements are expected to be greatest. For example, the peak construction year for Acton Storm Tanks would be Site Year 2 to 3 of construction (as shown in Section 3.3 of Vol 4).

3.5.7 The selected assessment year for each site and for the project-wide assessment and for each topic has been identified utilising best practice guidance, professional judgement and discussions with statutory stakeholders.

Assessment year: operation

3.5.8 For most topics, the assessment year for the assessment of operational effects is the first full 12 months of operation (excluding any commissioning period). Where this is not the case, this has been indicated within the individual topic methodologies.

3.5.9 No site would operate without the others all being complete and therefore Year 1 of operation is the same for all sites and across all topics, 2023.

Additional assessment years

3.5.10 In order to make sure that all the likely significant effects of the proposed development have been identified, a number of topics have considered additional assessment years as necessary. For example, the townscape and visual assessment has considered Year 15 of operation, in addition to Year 1 of operation, in order to account for a situation in which any mitigation planting has had the time to become established. Further detail can be found in each topic in Sections 4 to 15 of this volume.

Vol 2 Table 3.5.1 Summary of topic assessment years and scenarios

	Site-specific		Project-wide	
Topic	**Construction**	**Operation**	**Construction**	**Operation**
Air quality and odour	Local air quality: Peak construction year for each site. Construction dust: over the duration of the construction works.	Odour: typical use year representing typical rainfall levels.	Project-wide peak construction year.	Scoped out
Ecology-aquatic	Site Year 1 of construction	Year 1 (2023) and Year 6 (2029) of operation (when it is considered that there would have been a measurable recovery of receptor communities)	Project Year 1 of construction	Year 1 and Year 6 of operation (when it is considered that there would have been a measurable recovery of receptor communities)
Ecology-terrestrial	Entire construction phase	Scoped out	Scoped out	Scoped out
Historic environment	Above/below ground assets: all stages of the construction period. Setting of above ground heritage assets: peak construction year has been used.	Setting of above ground heritage assets: Year 1 of operation (2023).	Entire construction period.	Not assessed
Land quality	Site Year 1 of construction.	Scoped out	Scoped out	Scoped out
Noise and vibration	Various assessment periods for construction.	Year 1 of operation (2023)	Same as described for site-specific. Vibration assessment	Year 1 of operation (2023)

	Site-specific		Project-wide	
			has only been undertaken for project-wide level.	
Socio-economics	Peak year of construction. This is subject to two caveats: duration of impact has been taken into account and the amenity assessment is informed by assessment years for the respective effects for air quality, construction dust, noise and vibration (human response), and visual.	Year 1 of operation (2023)	Project-wide peak construction year. Regard has also been had to the total duration of the construction period.	Year 1 of operation (2023)
Townscape and visual	Peak construction year	Year 1 and Year 15 of operation.	Scoped out	Scoped out
Transport	Peak construction year	Year 1 of operation (2023)	Project-wide peak construction year * For construction barge activity – Project Year 2 of construction * Highway Network – Project Year 2 of construction * Public transport networks – Project Year 4 of construction Cluster assessments: * Central and eastern clusters: Project Year 4 of construction * Western cluster: Project Year	Scoped out

	Site-specific		Project-wide	
			2 of construction. Blackfriars Bridge Foreshore and Victoria Embankment Foreshore: Project Year 3 of construction	
Water resources - groundwater	Assessment years vary between sites depending on when and for how long certain construction activities happen eg, dewatering.	Year 1 of operation (2023)	Project-wide peak construction year.	Year 1 of operation (2023)
Water resources – surface water	Site Year 1 of construction (reliant on modelled simulation data which uses population projections predicted for 2021).	Year 1 of operation Climate change scenario: 2080.	Project Year 1 of construction (reliant on modelled simulation data which uses population projections predicted for 2021).	Year 1 of operation (2023)
Water resources- flood risk	Varying timeframes according to length of construction required	From 2023 onwards. Climate change scenario: 2111.	Varying timeframes according to length of construction required	From 2023 onwards Climate change scenario: 2111.

3.6 Spatial scope of assessment

3.6.1 This section describes the spatial scope of the assessment as well as the strategy for assessing the spatial parameters of the proposed development.

3.6.2 The spatial scope of the assessment is defined as the area over which changes to the environment are likely to occur as a result of the proposed development. The spatial scope of the assessment varies between topics by virtue of the types of impacts and resources and receptors. For example, impacts on buried archaeological resources are generally confined to the footprint of where construction works take place, whilst noise impacts may extend beyond construction site boundaries and affect nearby receptors. Meanwhile, water quality changes may occur both upstream and downstream of a CSO if works are proposed there. Therefore, assessment areas have been identified for each topic at both project-wide and site-specific level.

3.6.3 In terms of identifying base case and cumulative effects, information within 1km has generally been collected, as set out in Section 3.8.

3.6.4 All topics have assessed the proposed development. For the site works parameter plans, a spatial parameters approach has been used. The purpose of this approach is to enable reasonable flexibility to reflect likely modification during detailed design, whilst ensuring that the maximum extent of the proposed development is considered and that the effects of the project as it may be constructed have been properly assessed. Within these parameters, infrastructure may be located anywhere within a defined zone. These zones are colour coded as follows:

a. Dark blue dotted line – zone within which the shaft would be located

b. Green dotted line – zone within which all permanent site structures would be located

c. Purple dotted line – zone within which permanent above ground structures would be located. Note, there may be several purple polygons for a site, eg, one for a vent column, one for a kiosk

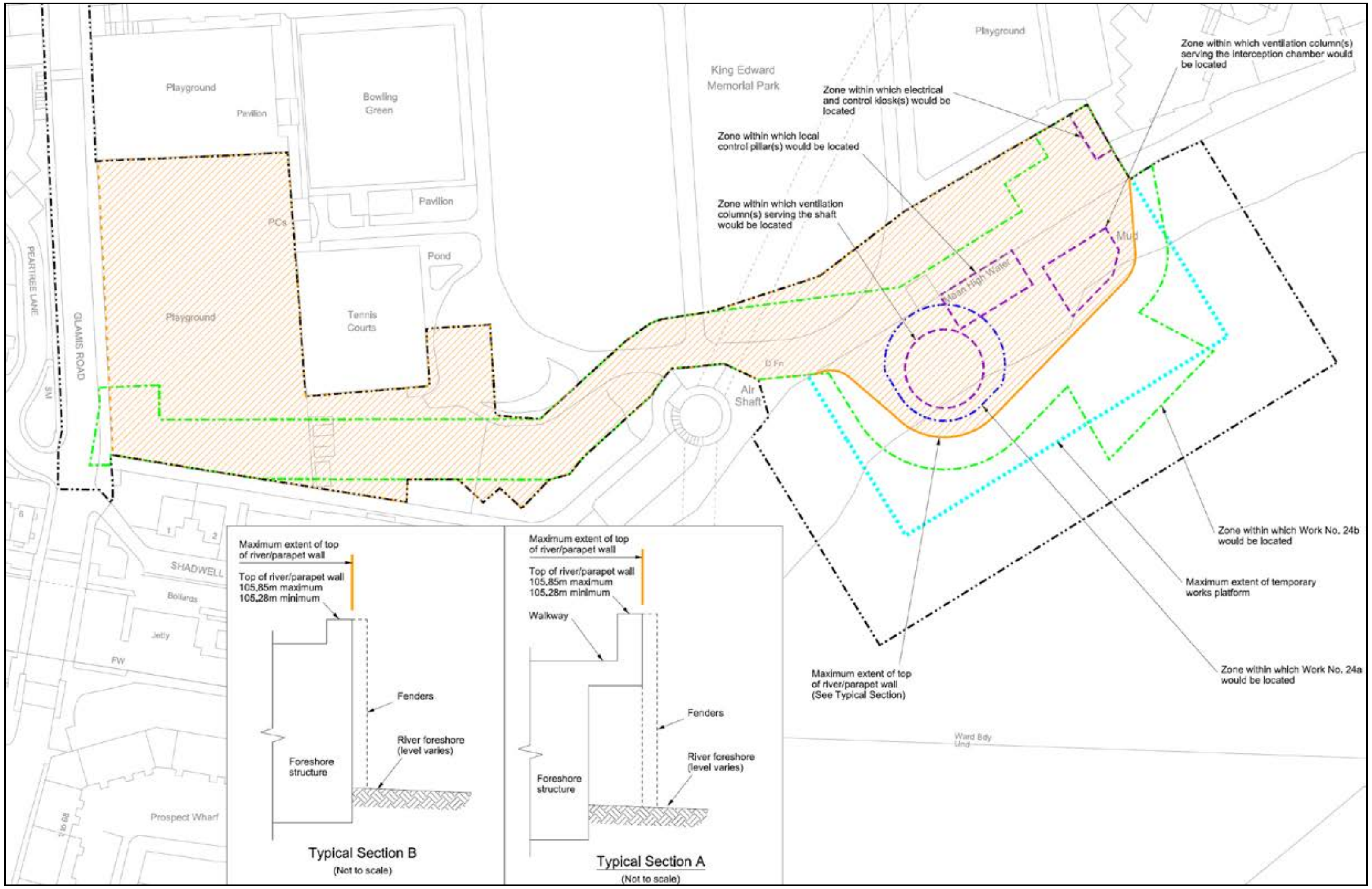
d. Orange hatched area – zone within which required landscaping would be located

e. Orange line – maximum extent of top of river parapet wall

f. Light blue dotted line – maximum extent of temporary works platform

3.6.5 These zones are illustrated in the example shown in Vol 2 Plate 3.6.1 below.

Vol 2 Plate 3.6.1 Example site works parameter plan



3.6.6 Following Planning Inspectorate guidance on the *'Rochdale envelope'* (Planning Inspectorate, 2012)[31] and adopting the higher level of impacts and effects approach to assessment, the parameter plans approach to defining the spatial extent of development may mean different assumptions depending on the topic. For example, the historic environment assessment may assume that the shaft would be located in the western end of the defined zone on the site parameter plan (indicated by the dark blue dotted line) as this would involve landtake of a historic asset whereas elsewhere within the zone there are no other historic assets. Meanwhile, the townscape and visual assessment may assume it was located at the eastern extent of the zone as this would result in the most adverse effect on visual amenity. Although ultimately the shaft could be located anywhere within the zone, the higher levels of effects for each topic are identified in this *Environmental Statement*. In this case, both effects can be considered equally likely, as the precise location of the shaft within the zone is not known at this stage. This approach is also in line with the *Waste Water NPS*[32].

3.7 Assessment of effects

Types of effects assessed

3.7.1 The *2009 EIA Regulations* requires the *Environmental Statement* to report on a number of different types of effects including direct, indirect, secondary, cumulative, short-, medium- and long-term, permanent and temporary, positive and negative.

3.7.2 For the purposes of this assessment, the following definitions have been used unless stated otherwise:

a. Direct effects: effects arising directly as part of the proposed development.

b. Indirect effects: effects not caused immediately by the proposed development, but arising as a consequence of it.

c. Secondary effects are deemed to be the same as indirect effects.

d. Cumulative effects: those effects that arise from the Thames Tideway Tunnel project with other non-Thames Tideway Tunnel projects. Cumulative effects are discussed in Section 3.8.

e. Short-term effects are generally defined in this assessment as less than 12 months; medium-term as 1 to 5 years; and long-term as + 5 years.

f. Permanent effects: effects that result in an irreversible change to the environment or for the foreseeable future.

g. Temporary effects: effects which cause a change for a limited period of time.

h. Positive effects are referred to in this assessment as beneficial effects.

i. Negative effects are referred to in this assessment as adverse effects.

3.7.3 All of these types of effects are assessed inherently as part of this *Environmental Statement*, which describes effects for construction and operation, and site-specific and project-wide levels.

3.7.4 No combined construction and operational phase is envisaged during the project (ie, the project would be constructed before any operational activity).

3.7.5 Section 3.8 on cumulative effects discusses other terms such as compound effects and interactive effects.

3.7.6 Where it has not been possible to quantify impacts, qualitative assessments have been carried out, based on professional experience and judgement. Where uncertainty exists, this has been noted in the relevant section.

Construction effects

3.7.7 The assessment of construction effects considers those effects which are likely to arise from site preparation, temporary construction activities and associated matters such as construction traffic and temporary haul roads. It also includes an assessment of effects which although arising during the construction phase, would result in permanent works and effects, such as the construction of shafts and the tunnels, and ventilation structures.

3.7.8 Many construction phase effects would be managed through the implementation of a *CoCP*, which forms part of the *Environmental Statement*. Where significant adverse effects are identified (after considering embedded measures from the *CoCP*), further ‘mitigation measures’ have been proposed.

Operational effects

3.7.9 The assessment of operational effects considers those effects which are likely to arise as a result of the operation and presence of permanent new infrastructure including any above ground buildings and structures, flows in the tunnels and shafts below ground and reduced outfalls. Operational effects could also arise as a result of maintenance activities.

Site-specific effects

3.7.10 Site-specific effects arise at or near discrete Thames Tideway Tunnel project sites. Most of the effects arising as a result of the project are site-specific since the project needs to be delivered using a number of discrete construction sites across London. For example, land quality effects are site-specific as they are constrained to the site footprint rather than project-wide. Site-specific effects also include effects of multiple Thames Tideway Tunnel project sites on receptors where the sites are in close proximity. These are often termed ‘compound effects’. More information is provided in para. 3.8.4b.

Project-wide effects

3.7.11 Project-wide effects arise at or near discrete sites but are also typically more wide-ranging, generally because of the nature of the impacts and the extensive nature of the resources and receptors. Project-wide effects have been defined as:

a. effects experienced over a wider geographical area than those identified and reported at individual site level, such as effects on the wider London transport network as a result of construction traffic

b. effects arising from tunnelling activities experienced along the route of the main tunnel and connection tunnels, such as effects on historic listed buildings and structures as a result of ground settlement

Assessing significance

3.7.12 The concept of significance is central to EIA and assigning it to effects is a means of allowing decision makers to be aware of the notable environmental effects. The *2009 EIA Regulations* require the assessment of 'significant' effects. However there is no statutory definition of what constitutes a significant effect.

3.7.13 The level of significance of an effect is commonly derived from combining measures evaluating the magnitude of impact and the value and sensitivity of the receptors affected.

3.7.14 Magnitude of impact is defined as the overall level of change in the environment and includes matters such as the duration and extent over which that impact occurs, the likelihood, frequency and reversibility, eg, an increase in noise to 70db as a result of construction piling. For the purpose of this assessment, magnitude has been categorised as either high, medium, low or negligible, unless stated otherwise.

3.7.15 For most topics, professional judgement has been used inherently to assess the likelihood or probability of an impact occurring. This influences the assessment of likely significant effects, whereby more weight is given to effects that are likely rather than unlikely. Aquatic and terrestrial ecology use the Institute of Ecology and Environmental Management (IEEM) Guidelines[33], which advocate a scaled approach to considering the degree of confidence in the assessment of the impact on ecological structure and function, ranging from 'certain / near certain' through to 'probable', 'unlikely' and 'extremely unlikely', linked where possible to quantified confidence levels. Flood risk meanwhile uses a risk based approach that is based on the probability of an event occurring as a result of the proposed development rather than a direct change in conditions. Historic environment notes that where information is insufficient to be able to quantify the asset significance with any degree of certainty, significance of environmental effect is given as uncertain. In spite of the nuances described above, topics focus and report on *likely* significant effects.

3.7.16 The value or sensitivity of a resource or receptor is generally defined as a function of a number of factors such as rarity, fragility, replaceability and importance of the resource, and is generally determined in a geographical context. For example, some ecological resources may be of national value (eg, Site of Special Scientific Interest), whereas others may only be of local value (eg, Local Nature Reserve). The sensitivity is also a function of the capacity of the resource to accommodate changes and to recover. For example, residents may be more sensitive to noise than businesses, as noise may impair on quality of life and ability to sleep. For the purpose of this assessment, value or sensitivity has been categorised as either high, medium or low, unless stated otherwise.

3.7.17 In order to allow comparison of effects to be made across the extent of the project and to allow a robust assessment of project-wide effects to be clearly understood, a series of generic significance criteria descriptors has been developed in the form of a significance matrix as shown in Vol 2 Table 3.7.1 below.

3.7.18 For most topics, the significance of effects has been determined by combining the identified impact magnitude, with the receptors affected by those impacts, taking into account their value and sensitivity as set out in Vol 2 Table 3.7.1. In the example above, effects would be worse for residents than businesses from construction noise assuming noise levels are the same.

3.7.19 As a general principle, moderate and major effects are deemed significant, whilst minor and negligible effects are deemed non-significant.

Vol 2 Table 3.7.1 Generic significance matrix

		Receptor value/sensitivity		
		High	**Medium**	**Low**
Impact magnitude	High	Major adverse / beneficial	Major adverse / beneficial	Moderate adverse / beneficial
	Medium	Major adverse / beneficial	Moderate adverse / beneficial	Minor adverse / beneficial
	Low	Moderate adverse / beneficial	Minor adverse / beneficial	Negligible effect
	Negligible	Minor adverse / beneficial	Negligible effect	Negligible effect

3.7.20 For some topics, the relevant professional bodies prefer approaches which only identify ‘significant’ or ‘not significant’ effects (rather than a graded scale of significance). In this case the red shaded area represents ‘significant effects’, and the green shaded area represents ‘not significant effects’.

3.7.21 Individual topic assessments have developed their own topic specific significance criteria based on topic specific guidelines and professional judgement. The criteria used to determine the magnitude of impact and the value of resources/receptors has been developed on a topic by topic basis in accordance with current legislation and policy, best practice guidelines and professional judgement. Where topic specific guidance stipulates the use of significance categories different to those shown on the generic significance matrix this is explained in the methodology for that topic.

3.8 Cumulative effects

Approach

3.8.1 Schedule 4, Part 1 of the *2009 EIA Regulations* requires an *Environmental Statement* to include the assessment of the cumulative effects. Schedule 3 of the *2009 EIA Regulations* refers to "...the cumulation with other development". 'Cumulative' is not defined in the EIA Directive or Regulations and there is no standard approach to the assessment of cumulative effects, with different projects adopting different approaches.

3.8.2 A range of guidance has informed this project's approach to cumulative effects including *PINS Advice Note 9* (Planning Inspectorate, 2012)[34] and the National Policy Statement for Waste Water (HM Government, 2012)[35].

3.8.3 For this project, cumulative effects are defined as those that arise from the Thames Tideway Tunnel with other non-Thames Tideway Tunnel projects.

3.8.4 For clarity, the following are not considered as part of the cumulative effects assessment but are considered elsewhere as part of the assessment:

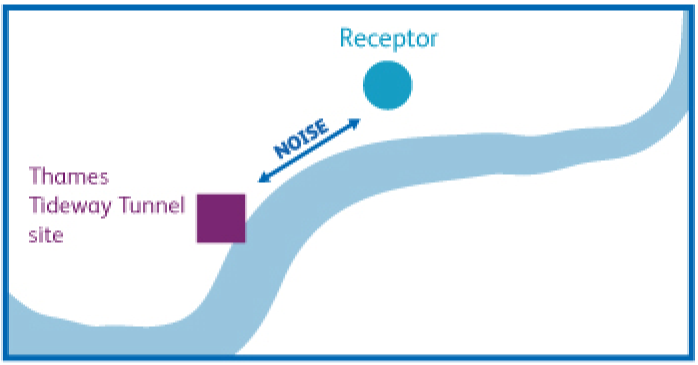
a. Multiple effects on a single receptor such as noise, dust, air quality and visual. These are often termed 'interactive effects' or 'in combination effects'. The treatment of such interactive effects is inherent within the topic assessments. For example, the assessment of amenity effects inherently assesses combined noise, air quality and visual effects. As such 'interactive effects' or 'in combination effects' do not require separate consideration.

b. Effects of multiple Thames Tideway Tunnel project sites where the sites are in close proximity. These are often termed 'compound effects'. This is integral to topic site assessments and project-wide assessments. For example, when assessing construction effects at Kirtling Street, works taking place at Heathwall have been taken into account in the assessment (as the sites would not be developed in isolation). As such, compound effects are not presented under cumulative effects or on their own.

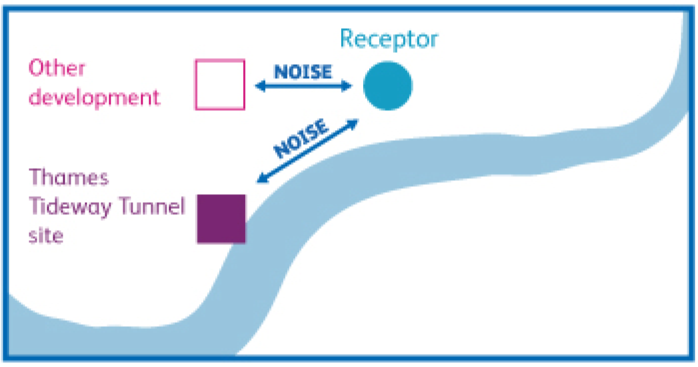
3.8.5 These types of effects are summarised in Vol 2 Plate 3.8.1.

Vol 2 Plate 3.8.1 Types of effects assessed

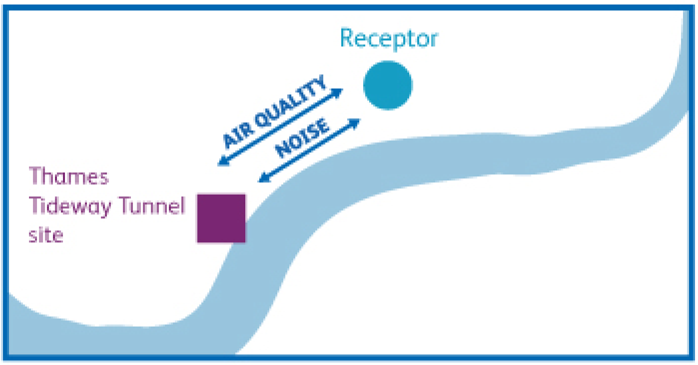
1. Direct and indirect effects.



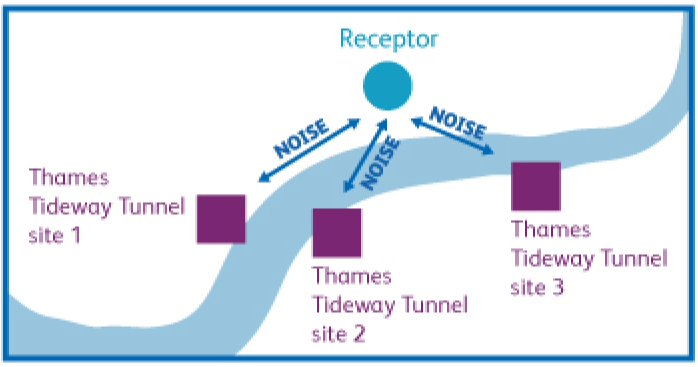
2. Cumulative effects.



3. Interactive effects / in combination effects.



4. Compound effects.



3.8.6 Using the definition of cumulative effects above, an approach was developed to identify those developments to be considered within the cumulative effects assessment. A series of criteria was developed with regard to the following:

a. Planning status – identifying categories of developments to be considered, based on levels of certainty of being implemented

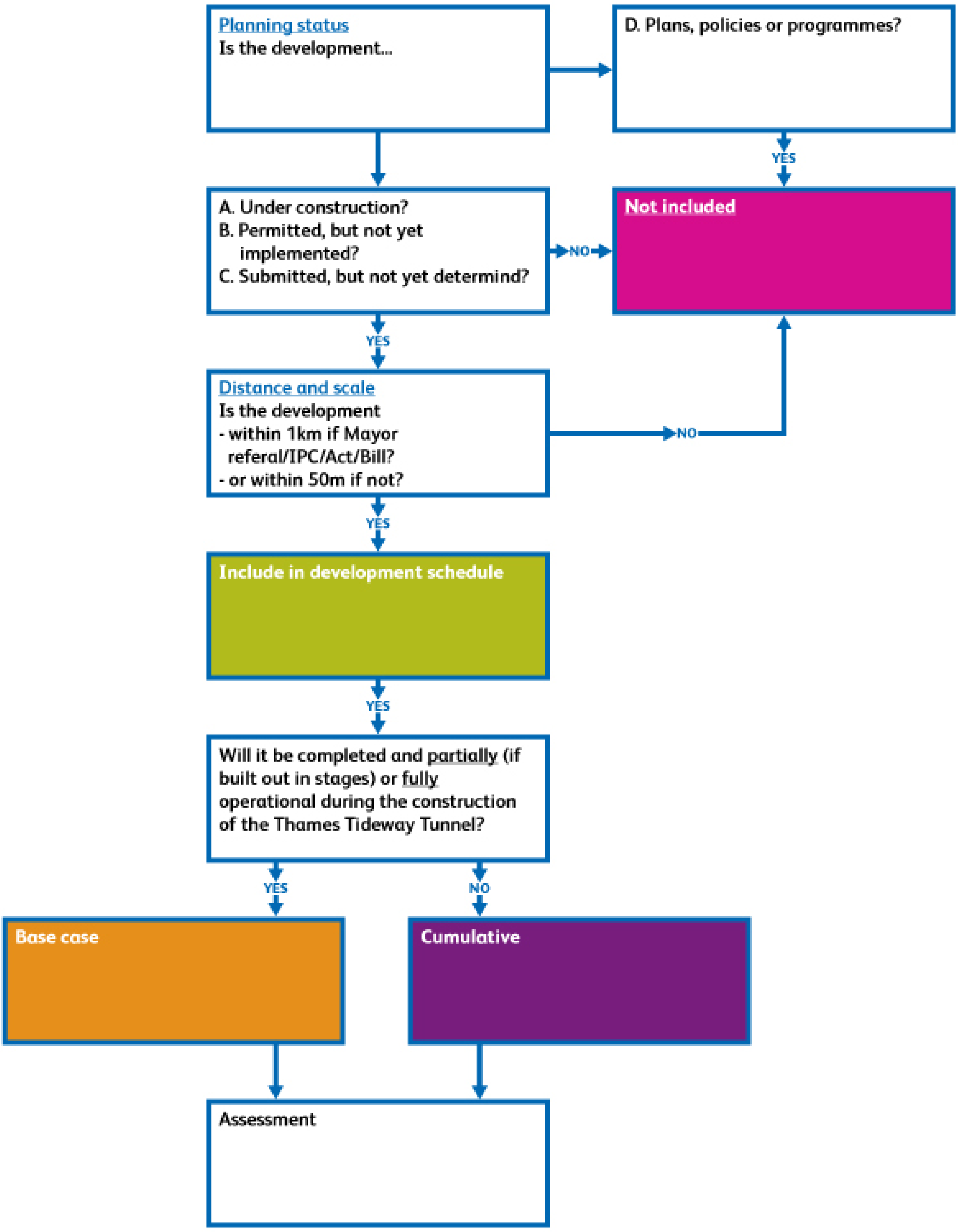
b. Distance

c. Scale of project

d. Cumulative or base case

3.8.7 These are discussed in turn as follows and represented in Vol 2 Plate 3.8.2.

Vol 2 Plate 3.8.2 Approach to identifying cumulative and base case schemes



Note – as described in para. 3.8.11 the transport assessment uses a model that is considered inherently cumulative, ie, take category D plans, policies and programmes into account.

Planning status

3.8.8 Developments have different levels of certainty of being implemented, reflecting the stage that they are at in the planning process. The following categories have been informed by *PINS Advice Note 9* (Planning Inspectorate, 2012)[36] and the IPC Section 51 Advice (see Vol 2 Appendix A.3) for the Thames Tideway Tunnel project:

a. Category A – Under construction

b. Category B – Permitted but not yet implemented

c. Category C – Submitted but not yet determined

d. Category D – Plans, policies and programmes – includes the *London Plan 2011* and plans of local authorities as set out in *Adopted Development Plan Documents* (*DPDs*), emerging development plans and specific site allocations as set out in *DPDs*

3.8.9 Rejected planning applications have not been considered as there is deemed to be less certainty that they will be implemented, even though revised applications may be submitted in future.

3.8.10 Where there is a live appeal on a planning application decision, this has been included in category C. Where an appeal has been rejected, this has not been considered and is considered as a rejected planning application.

3.8.11 The transport assessment (See Vol 2 Section 12 and related air quality, noise and amenity assessments) is based on modelling using the Transport of London's strategic highway models that cover London and its surrounding area. These models are developed using population and employment forecasts which are partly based on the GLA employment and population forecasts, based on the employment and housing projections set out in the *London Plan 2011*. As a result the models are considered inherently cumulative as they take into account a level of future growth and development across London, ie, take category D plans, policies and programmes into account. Traffic associated with developments beyond the 1km radius are also inherently included.

3.8.12 However, it has been concluded that for other environmental topics, while relevant plans, policies and programmes (category D above) can be identified, limited or no information is available on the design and timescales for implementation of the policies which is required for a robust assessment of cumulative effects to be undertaken. Additionally, there is no guarantee that a proposal within a *Development Plan* or other policy document will actually proceed as proposed and should development proposals come forward, these would, in any case, be likely to require an environmental impact assessment themselves (ie, they are 'later than the Thames Tideway Tunnel project' in the planning system).

3.8.13 For these reasons, category D developments have not been assessed for topics other than transport related topics. It is noted that this approach is consistent with that recently taken on other large infrastructure projects such as Hinkley Point C (EDF Energy, 2012)[37] and Rookery South (Covanta Rookery South Limited, 2012)[38].

3.8.14 This position is supported by case law and decisions which clarify that an ES is only required to include such information as the applicant can reasonably be required to compile, having regard in particular to current knowledge. Case law has clarified how this rule applies in practice when determining which committed schemes must be included in the EIA cumulative assessment. In the Littlewood case[39] the High Court held that there was no legal requirement for a cumulative assessment of future development of adjoining land where there was no way of knowing what development was proposed or was reasonably foreseeable. The same legal approach was recently followed in the Kylun appeal against the London Borough of Lambeth[40], where the Inspector dismissed an objection against a purported failure to carry out cumulative wind impact assessment because "the appellant cannot be expected to base an assessment on developments that are at design stage and could alter before being implemented".

Distance

3.8.15 Information has been collected on developments within the above categories within a 1km radius of each Thames Tideway Tunnel project site. This is considered to be a suitably wide area to ensure that all potentially significant cumulative effects are identified and assessed. This is not the same as 1km from the main tunnel or connection tunnels because it is not deemed that they would interface with or impact on above ground developments.

3.8.16 While development information is provided within a 1km radius of sites, topics have only considered developments of relevance. For example, aquatic ecology is only concerned with in-river development, development adjacent to the river or development discharging into the river, therefore all other land-based developments have been excluded. Assessment areas are defined within each topic in Vol 2 Sections 4 to 15 and also within the site assessments.

Scale of project

3.8.17 In terms of the scale of developments considered in categories A-C, the following large scale developments have been considered:

a. Nationally Significant Infrastructure Projects (NSIPs).

b. Mayoral referral schemes. Appendix N.1 sets out the criteria used to identify those applications that are referable to the Mayor.

c. Parliamentary acts and bills for priority projects (eg, Crossrail, Thameslink,) have been considered (as identified in the *National Infrastructure Plan 2011*[41]).

3.8.18 The only exception to this is developments within 50m which due to their proximity to site are included in the development schedules as possible new sensitive receptors, irrespective of whether they are NSIPs, Mayor referable or priority projects.

Cumulative versus base case

3.8.19 The developments for assessment have been differentiated into those to be assessed as part of the 'base case' (ie, future year 'without Thames Tideway Tunnel project' scenario) and those assessed as part of the cumulative effects assessment.

3.8.20 The base case is discussed earlier in Section 3.4. It includes developments within categories A-C, within 1km if NSIPs, Mayor referable or priority projects or 50m otherwise, that are programmed to be completed and partially (if built out in phases) or fully operational during construction of the Thames Tideway Tunnel project. This is proposed on the basis that these developments will be in place when Thames Tideway Tunnel project construction is taking place and therefore it is appropriate to assume their presence in the base case (ie, 'without Thames Tideway Tunnel project' scenario).

3.8.21 The assessment of cumulative effects meanwhile considers those developments that are programmed to be under construction or operational at the same time as the Thames Tideway Tunnel project.

Development schedules

3.8.22 Development schedules have been produced for each Thames Tideway Tunnel project site (see Vol 4 to 27, Appendix N) and for parliamentary acts and bills for priority projects (see Vol 3, Appendix A.2) level.

3.8.23 Details were gathered as follows:

a. Development details – name, application number, developer and development description

b. Distance of development from the Thames Tideway Tunnel project site (at closest point from Thames Tideway Tunnel project limits of land to be acquired or used (LLAU) boundary)

c. Category of development – either A, B or C.

d. Assumptions about the development in each assessment year in terms of degree of completion. The years specified in each site schedule reflect the years assessed within this *Environmental Statement*

e. Confirmation of whether the development will be treated as base case or assessed under cumulative effects in each of the assessment years.

3.8.24 It is possible that a phased development project would be considered as both base case and cumulative. In such cases the completed part of a development (in a given assessment year) would be considered as base case, while the part of the development under construction would be assessed in the cumulative effects assessment.

3.8.25 These schedules are based on best available knowledge regarding the status of each development in specified assessment years (eg, Site Year 1 of construction, peak construction year, Year 1 of operation). This is based on the review of planning application documentation and drawing on discussions with developers and local authorities where appropriate.

The *Mayor's London Development Database* (Greater London Authority, 2012)[42] has also been used to identify whether permitted planning applications have started construction.

3.8.26 Some identified developments appear in more than one development schedule. This is deliberate and reflects the fact that one site can be within a 1km radius of two or more sites.

3.8.27 To inform the topic assessments, *Environmental Statements* and site layout plans were also collated for those developments in the development schedules to enable robust assessments.

3.8.28 No Thames Water schemes have been identified as being relevant to the base case or cumulative assessments. This applies to Counters Creek, which does not meet the criteria set out above for inclusion of schemes.

Consultation

3.8.29 This proposed approach was set out in a position paper which was issued in February 2012 to the stakeholders set out in Appendix N.2 which indicates whether a response was received. Further detail on the nature of the responses is provided in Appendix N.3.

3.8.30 A number of responses to the position paper acknowledged or agreed with the project's proposed approach to the cumulative effects. The majority of stakeholders suggested additional schemes for consideration. These have been considered using the criteria set out above and in many cases added to the development schedules. Some were rejected on the basis that they do not meet the criteria for consideration by the project or an application had not actually been submitted. These were then checked again in September 2012 to confirm whether they had become 'live', ie, that an application had been submitted. Where this was the case, the applications have been added to the development schedules.

3.8.31 A couple of respondents challenged the approach to cumulative effects with comments relating to the treatment of interactive effects, multiple Thames Tideway Tunnel project sites, terrestrial ecology, transport, spatial scope.

3.8.32 Overall, engagement with stakeholders demonstrated support for the approach to cumulative effects and enabled additional more accurate and comprehensive development schedules to be developed.

3.8.33 A follow up note was circulated to the same stakeholders identified in Appendix N.2 in September 2012 which set out the comments received and responses to those comments. It also included updates to the development schedules and sought final feedback on them, in particular on any new developments for which planning applications have been submitted since February 2012 (when stakeholders last provided input). Comments were requested back by 5 October, after which the schedules were fixed for the purposes of the EIA. This 'fix date' was required to enable sufficient time to undertake a robust assessment as part of the *Environmental Statement*, whilst being sufficiently up to date to reflect the point at which the application is submitted.

3.8.34 In terms of feedback to the second position paper, just under half of the stakeholders responded. Four stakeholders provided general comments whilst three stakeholders identified additional schemes for consideration and/or provided updated details on schemes already in the development schedules. These were considered using the criteria set out above. Where appropriate these schemes have been added to the development schedules whilst in a number of cases the status of the schemes have been changed, eg, where schemes have had planning applications approved meaning that they change from category C to B. Some schemes were rejected on the basis that they do not meet the criteria for consideration by the project, for example, the scheme is not referable to the Mayor of London or is outside of the 1km buffer considered for each site.

3.8.35 Further detail on the nature of the responses is provided in Appendix N.4.

Undertaking the cumulative effects assessment

3.8.36 The information in the development schedules has been considered and assessed in the environmental topics. This has been done using the same assessment years as used for the topic assessments. This involves considering future conditions with the Thames Tideway Tunnel project and then evaluating if other developments are likely to give rise to elevated effects above and beyond those assessed for the Thames Tideway Tunnel project.

3.8.37 A quantitative assessment has been undertaken whenever possible eg, the strategic modelling work undertaken for the assessment of transport effects includes allowances for population and employment growth, based on the projections in the London Plan 2011, and is therefore inherently cumulative.

3.8.38 For those topics where a quantitative assessment is not be possible or appropriate, a qualitative evaluation has been carried out using professional judgement to consider whether these other developments would be likely to elevate the effects identified.

3.8.39 For those topics that do not assess a specific year (eg, noise and vibration which instead assesses duration of construction activities), the information in the development schedules has been used to gain an understanding of those developments likely to be under construction at the same time as the Thames Tideway Tunnel project site. A qualitative assessment has then been undertaken on that basis.

3.8.40 The cumulative effects assessment has been done at a site level as well as at a project-wide level for those topics undertaking a project-wide assessment.

3.9 Environmental Statement contents

3.9.1 Taking into account the matters covered in Sections 1 to 3 of this volume, the overall structure for the project-wide (Vol 3) and site assessments (Volumes 4 to 27) is as follows for each topic except flood risk:

a. Introduction

b. Proposed development relevant to topic

c. Assessment methodology (including assessment assumptions and limitations)

d. Baseline conditions

e. Construction effects assessment

f. Operational effects assessment

g. Cumulative effects assessment

h. Mitigation

i. Residual effects assessment

j. Effects assessment summary

3.9.2 For topics that have been scoped out or not assessed of particular site assessments (Volumes 4 to 27), information is provided on engagement, baseline and an overview as to why the topic has been scoped out or not assessed.

References

[1] *Planning Act 2008* (as amended). Available at: http://www.legislation.gov.uk/ukpga/2008/29/contents. Accessed 17 July 2012.

[2] Infrastructure Planning. (*Environmental Impact Assessment) Regulations 2009*. Available at: http://www.legislation.gov.uk/uksi/2009/2263/contents/made. Accessed 17 July 2012.

[3] Infrastructure Planning. *(Environmental Impact Assessment) (Amendment) Regulations 2012*. Available at: http://www.legislation.gov.uk/uksi/2012/787/contents/made. Accessed 16 August 2012.

[4] 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. Accessed 25 June 2012.

[5] Infrastructure Planning (Waste Water Transfer and Storage) Order 2012. Available at: http://www.legislation.gov.uk/uksi/2012/1645/contents/made. Accessed 26 October 2012.

[6] Department of Communities and Local Government. *National Planning Policy Framework* (March 2012). Available at: http://www.communities.gov.uk/planningandbuilding/planningsystem/planningpolicy/planningpolicyframework/. Accessed 17 July 2012.

[7] Department of Communities and Local Government. *Circular 02/1999 Environmental Impact Assessment* (2000). Available at: http://www.communities.gov.uk/documents/planningandbuilding/pdf/155958.pdf. Accessed 4 July 2012.

[8] Department of Communities and Local Government. *Circular 01/2006 Guidance on Changes to the Development Control System* (2006). Available at: http://www.communities.gov.uk/documents/planningandbuilding/pdf/144854.pdf. Accessed 4 July 2012.

[9] Department of Communities and Local Government. *Amended Circular on Environmental Impact Assessment* (consultation paper, June 2006). Available at: http://www.communities.gov.uk/documents/planningandbuilding/pdf/151738.pdf. Accessed 4 July 2012.

[10] Department of Communities and Local Government. *Environmental Impact Assessment: A guide to good practice and procedures: A consultation paper* (2006). Available at: http://www.communities.gov.uk/documents/planningandbuilding/pdf/151087.pdf. Accessed 21 June 2012.

[11] European Commission. *Guidance on EIA Scoping* (June 2001). Available at: http://ec.europa.eu/environment/eia/eia-guidelines/g-scoping-full-text.pdf. Accessed 4 July 2012.

[12] Planning Inspectorate. *Advice note 3: EIA notification and consultation*. Version 4 (May 2012). Available at: http://infrastructure.planningportal.gov.uk/wp-content/uploads/2012/05/Advice-note-3v3.pdf. Accessed 21 June 2012.

[13] Planning Inspectorate. *Advice note 6: Preparation and submission of application documents*. Version 5 (June 2012). Available at: http://infrastructure.planningportal.gov.uk/wp-content/uploads/2012/06/Advice-note-6-version-5.pdf. Accessed 21 June 2012.

[14] Planning Inspectorate. *Advice note 7: Environmental Impact Assessment, screening and scoping*. Version 3 (April 2012). Available at: http://infrastructure.planningportal.gov.uk/wp-content/uploads/2012/03/Advice-note-7v2.pdf. Accessed 21 June 2012.

[15] Planning Inspectorate. *Advice note 9: Using the 'Rochdale Envelope'*, version 2 (April 2012). Available at: http://infrastructure.planningportal.gov.uk/wp-content/uploads/2012/03/Advice-note-9.pdf. Accessed 21 June 2012.

[16] Planning Inspectorate. *Advice note 12: Development with significant transboundary impacts consultation*, version 3 (April 2012). Available at: http://infrastructure.planningportal.gov.uk/wp-content/uploads/2012/03/Advice-note-12.pdf. Accessed 19 July 2012.

[17] Planning Inspectorate. *Advice note 14: Compiling the consultation report*. Version 2 (April 2012). Available at: http://infrastructure.planningportal.gov.uk/wp-content/uploads/2012/03/Advice-note-14.pdf. Accessed 4 July 2012.

[18] Environment Agency. *Scoping guidelines for the Environmental Impact Assessment of Projects* (May 2002).

[19] IEMA. *Guidelines for Environmental Impact Assessment* (2004).

[20] European Commission. *Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions* (1999). Available at: http://ec.europa.eu/environment/eia/eia-studies-and-reports/guidel.pdf. Accessed 4 July 2012.

[21] Department of Communities and Local Government. *Environmental Impact Assessment: A guide to good practice and procedures: A consultation paper* (2006). See citation above.

[22] Town and Country Planning. *(Environmental Impact Assessment) (England and Wales) Regulations 1999*. Available at: http://www.legislation.gov.uk/uksi/1999/293/contents/made. Accessed 16 August 2012.

[23] Department of Communities and Local Government. *Environmental Impact Assessment: A guide to good practice and procedures: A consultation paper* (2006). See citation above.

[24] Thames Water. *EIA Scoping Report* (2011). Available at: http://www.thamestunnelconsultation.co.uk/document-library/catalogue-view/?c=4-eia-scoping-report.

[25] Thames Water, *Preliminary environmental information report* (November 2011). Available at: http://www.thamestunnelconsultation.co.uk/document-library/catalogue-view/?c=3-preliminary-environmental-information-report. Accessed 6 January 2013.

[26] Thames Water, *Main Report on Phase 1 Consultation* (2011). Available at: http://www.thamestunnelconsultation.co.uk/document-library/timeline-view/. Accessed 9 November 2012.

[27] Planning Inspectorate. *Advice note 12*. See citation above.

[28] Thames Water (November 2011). See citation above.

[29] Planning Inspectorate. *Advice note 9*. See citation above.

[30] Planning Inspectorate. *Advice note 9.* See citation above.

[31] Planning Inspectorate. *Advice note 9.* See citation above.

[32] HM Government. *National Policy Statement for Waste Water*. See citation above, pages 23-24.

[33] Institute of Ecology and Environmental Management. *Guidelines for Ecological Impact Assessment in the United Kingdom* (2006).

[34] Planning Inspectorate. *Advice note 9.* See citation above.

[35] HM Government. *National Policy Statement for Waste Water*. See citation above.

[36] Planning Inspectorate. *Advice note 9.* See citation above.

[37] EDF Energy. *Hinkley Point C New Nuclear Power Station DCO application*. Available at: http://infrastructure.planningportal.gov.uk/projects/south-west/hinkley-point-c-new-nuclear-power-station/. Accessed 4 July 2012.

[38] Covanta Rookery South Limited. *Rookery South Energy from Waste Generating Station*. Available at: http://infrastructure.planningportal.gov.uk/projects/eastern/rookery-south-energy-from-waste-generating-station/. Accessed 4 July 2012.

[39] R (on the application of Littlewood) v Bassetlaw District Council [2008] EWHC 1812 (Admin). Available at:

http://www.unece.org/fileadmin/DAM/env/pp/a.to.j/Jurisprudence_prj/UNITED_KINGDOM/Littlewood/LittlewoodJudgment.pdf. Accessed 29 October 2012.

[40] Secretary of State, Kylun Ltd and London Borough of Lambeth [2012]. Application reference 10/02060/FUL. Vauxhall Island Site, plot bounded by Parry Street, Bondway and Wandsworth Road, London SW8 1SJ. APP/N5660/A/11/2157961. Available at: http://www.communities.gov.uk/documents/planning-callins/pdf/2202271. Accessed 29 October 2012.

[41] HM Treasury. National Infrastructure Plan 2011. Available at: http://cdn.hm-treasury.gov.uk/national_infrastructure_plan291111.pdf. Accessed 29 October 2012.

[42] Greater London Authority. *London Development Database*. Available at: https://ldd.london.gov.uk/LDD/LDD/welcome.do. Last accessed 25 June 2012.

This page is intentionally blank

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.02**

Volume 2: Environmental assessment methodology

Section 4: Air quality and odour

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

Hard copy available in

Box **16** Folder **A**
January 2013

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

This page is intentionally blank

Thames Tideway Tunnel

Environmental Statement

Volume 2: Environmental assessment methodology

Section 4: Air quality and odour

List of contents

Page number

List of plates

Page number

List of tables

Page number

4 Air quality and odour

4.1 Introduction

4.1.1 This section sets out the methodology for assessing the likely significant effects of the Thames Tideway Tunnel project on air quality and odour.

4.1.2 The methodologies outlined in this section have been applied to all sites, unless otherwise indicated in the site assessment volumes. The methodology for assessing project-wide effects is also described.

4.1.3 The need for an assessment of air quality and odour effects results from the potential for the project to result in emissions during the construction and operational phases.

4.1.4 The local air quality assessment[i] has examined the effects of the project during construction arising from road transport, tugs (for river barges) where relevant and plant and equipment (compressors, generators, cranes, etc). The air quality assessment also includes a construction dust assessment and an assessment of pollution from the excavation of contaminated land at one of the project sites (Earl Pumping Station). This includes an odour assessment at Earl Pumping Station which has examined the effects of odours emanating from the excavation of this contaminated land.

4.1.5 For the assessment of operational effects, an odour assessment has been undertaken which assesses emissions from the ventilation structures at the project sites. Operational transport effects have been scoped out from the assessment of air quality due to the very limited number of maintenance visits required and hence the low number of vehicular movements.

4.1.6 The topic specific methodology presented in this section builds upon the general assessment methodology summarised in Section 3 and develops this to take account of the range of likely significant environmental effects on air quality and odour arising from the construction and operation of the project.

4.2 Engagement

4.2.1 The general approach adopted regarding engagement is summarised in Section 2.

4.2.2 Local authorities are the main consultees for local air quality and dust and odour nuisance effects. Engagement with the local authorities has been an ongoing process. This engagement started at the pre-scoping stage with an initial presentation of the proposed methodologies to

[i] A local air quality assessment usually involves the prediction of concentrations within short distances of relevant emissions sources (typically 200m) and is characterised by pollutants with immediate impacts, which are generally defined by the UK air quality objectives and the EU Limit Values.

representatives of all of the local authorities concerned at an Environmental Health Officers (EHO) Forum (November 2010). Following this forum, a position paper on air quality and odour was sent to all local authorities for comment and to obtain a common agreement on the methodology to be employed for the assessment of the project. Initial feedback was received following which a further document for the local authorities was circulated as a basis for further consultation.

4.2.3 Further EHO Forums were held in February 2011 and April 2011 and the *Scoping Report (*Thames Water, 2011)[1] was published in March 2011 requesting local authorities to provide opinions on all topics including air quality and odour. These scoping opinions are included in Vol 2 Appendix A.2 and B.1. The IPC also provided a response to the *Scoping Report* (see Vol 2 Appendix A.3), focusing on the receptors considered, types of effects, modelling and mitigation. These have been addressed in this *Environmental Statement*.

4.2.4 In spring 2011, the local authorities were also asked to supply air quality monitoring and odour complaint data for inclusion in the baseline study. At this stage, they were also asked for their opinion on the monitoring locations selected by the team to measure local air pollutants. Furthermore, the local authorities were asked to select any sensitive receptors that they felt required assessment. Responses have been collated and included in subsequent reporting.

4.2.5 Consultation continued through 2011 with phase two public consultation then undertaken between November 2011 and February 2012. This included the publication of a *Preliminary environmental information report (PEIR)* which set out the detailed assessment methodology, baseline conditions and preliminary assessment results (based on the phase two scheme) for air quality and odour.

4.2.6 Responses from statutory stakeholders to the phase one, phase two, interim, targeted and Section 48 consultations have been compiled and responded to within the site volumes (Volumes 4 to 27).

4.2.7 A summary of the scoping, stakeholder engagement and consultation comments relevant to the air quality and odour methodology, including responses to these comments, are provided in Vol 2 Appendix B.1. This shows that key issues raised in relation to the air quality and odour assessment include the requirement for baseline monitoring, the location of receptors, meteorological data, emission factors, dust assessment methodology, modelled odour scenarios, the need for a cumulative impact assessment, mitigation measures for construction dust, traffic and plant and the *Air Management Plan*.

4.3 Legislation and guidance

4.3.1 The assessment methodology has been developed using relevant legislation and air quality guidance documents. This includes the following:

a. *Environment Act*

b. *UK Air Quality Strategy* (Defra, 2007)[2]

c. *The Air Quality Standards Regulations 2010*

d. *Air Quality (England) Regulations 2000 and Air Quality (England) (Amendment) Regulations 2002*

e. *Air Quality Framework Directive 96/62/EC*

f. *Air Quality Directive 2008/50/EC*

g. *The Non-Road Mobile Machinery Regulations 1999 and Amendment Regulations 2005*

h. *Clean Air Act (1993)*

i. Institute of Air Quality Management, *Guidance on the Assessment of the Impacts of Construction on Air Quality and the Determination of their Significance* (Institute of Air Quality Management, 2012)[3]

j. *GLA Best Practice Guidance: Control of Dust and Emissions from Construction and Demolition* (Greater London Authority and London Councils, 2006)[4]

k. *Minerals Policy Statement 2* (Office of the Deputy Prime Minister, 2005)[5]

l. *Design Manual for Roads and Bridges* (DMRB), Volume 11, Section 3, Part 1 (Highways Agency, 2007)[6]

m. BRE Control of Dust from Construction and Demolition Activities (Building Research Establishment, 2003)[7]

n. *CIRIA Environmental Good Practice on Site* (CIRIA, 2010)[8]

o. Environmental Protection UK (EPUK), *Development Control: Planning For Air Quality*, (2010 Update)[9].

p. National Policy Statement (NPS) for Waste Water (Defra, March 2012)[10]

q. Odour Guidance for Local Authorities (Defra, March 2010)[11]

r. H4 Odour Management (Environment Agency, March 2011)[12]

4.3.2 The way in which these legislative and guidance documents have informed the air quality and odour assessment is described below.

4.3.3 Vol 2 Table 4.3.1 presents the requirements within the National Policy Statement for Waste Water (NPS) relevant to air quality and odour and explains how the requirements have been addressed within the ES. The table also gives the location of the relevant material.

Vol 2 Table 4.3.1 Air quality and odour – requirements of the NPS and how they have been addressed

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
The assessment provided by the applicant should include	The plant and processes are described in Vol 4-27 of the	Section 3 of Vol 4-27

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
a description of the component plant and processes of the development which will give rise to odour.	*Environmental Statement*.	
The assessment provided by the applicant should include nature of the odour emissions from the identified sources.	The nature of the odour emissions are described in Vol 2 of the *Environmental Statement*.	Section 4.3 (odour)
The odour assessment provided by the applicant should include consideration of the prevailing wind conditions.	The prevailing wind conditions are described in Vol 2 of the *Environmental Statement*.	Section 4.6
The odour assessment provided by the applicant should include premises or locations that may be affected by the emissions and the effects in those receptors.	The premises and locations that may be affected by emissions are assessed in the Vol 4-27 of the *Environmental Statement*. All sites achieve the 98^{th} percentile standard.	Sections 4.4 and 4.6 of Vols 4-27
The assessment provided by the applicant should include measures to be employed to prevent or mitigate odorous emissions.	These measures are described in the *Environmental Statement* and *Air Management Plan*.	Section 4.2 (odour) of Vols 4-27 and *Air Management Plan*.
It is important for the decision maker to consider the impact of odour emissions from waste water infrastructure not from the narrow perspective of nuisance but to consider the broader impact on amenity. Nuisance does not equate to a loss of amenity as significant loss of amenity will occur at lower levels of odour emission than would constitute a nuisance.	All of the sites have been assessed in relation to the EA odour benchmark for the 98^{th} percentile of hourly average concentrations set at $1.5ou_E/m^3$. This standard is widely used to assess and control the odour impact of new developments through the planning control regime, and can be a very effective means of both protecting amenity and therefore preventing or controlling future statutory nuisance from odours at the planning stage according to Defra in its Odour Guidance for Local Authorities[13]. Achieving this standard is considered both to prevent	Section 4.6

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
	nuisance and to prevent any significant loss of amenity. Modelling has been carried out to predict the number of hours in a year with odour above 1.5ou_E/m^3 which can be used to identify the number of hours in a year in which an odour might be detectable as an hourly average concentration.	
The odour impact assessment should also include consideration of ancillary activities associated with the project, for example, transport of sludge	There are no ancillary activities associated with the project that could give rise to significant odour.	N/A
The odour impact assessment should also include consideration of ancillary activities associated with the project, for example, emergencies such as loss of sludge disposal route.	An emergency operation of the Thames Tideway Tunnel project eg, major plant failure, could include failure of the Odour Control Units (OCU). This has not been assessed as failure of the OCU would not be expected to last for long enough to affect the 98th percentile standard.	N/A
The applicant should undertake an assessment of the impacts of the proposed project as part of the *Environmental Statement*.	An air quality assessment has been undertaken for each site and project wide as part of the ES.	Section 4.6 of Vols 3-27
The ES should describe any significant air emissions, their mitigation and any residual effects distinguishing between the project stages, and taking account of any significant emissions from any road traffic generated by the project have been applied	The air quality assessment has described and assessed all significant sources of emissions from the construction sites and also emissions from construction road traffic generated by the project. Mitigation measures have been identified, primarily within the *Code of Construction Practice* (*CoCP)*. The Code of Construction Practice (CoCP) is provided in Vol 1 Appendix A. It contains general requirements (Part A), and site specific requirements (Part B). Residual effects have also been	Section 4.5 of Vol 3-27 and *CoCP* Part A and Part B.

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
	discussed in the assessment.	
The ES should describe the predicted absolute emission levels from the proposed project, after mitigation methods	The emissions have been input into the relevant dispersion models to produce predictions of the effects of the emissions from the project on concentrations.	Section 4.5 of Vol 4-27
The ES should describe existing air quality levels and the relative change in air quality from existing levels.	Baseline concentrations have been described and modelled in the *Environmental Statement* and the change assessed relative to the base case of the project.	Sections 4.4 and 4.5 of Vol 4-27
The applicant should assess the potential for emissions of dust to have a detrimental impact on amenity, as part of the *Environmental Statement*.	The dust assessment has been undertaken in accordance with the guidance produced by the Institute of Air Quality Management (IAQM)[14] to assess the potential effects of dust in terms of both amenity and dust nuisance. The output from the dust assessment is also used as an input to the socio-economic assessment in the *Environmental Statement*	Section 4.5 of Vol 4-27
The applicant should describe the type, quantity and timing of emissions	The dust assessment has been undertaken in accordance with the guidance produced by the IAQM. This assessment is qualitative based on the amount of demolition, construction, excavation and movement of construction vehicles that occurs during the construction period as a whole.	Section 4.5 of Vol 4-27
The applicant should describe aspects of the development which may give rise to emissions	The construction operations that may give rise to emissions of dust are detailed in the ES.	Section 4.2 of Vol 4-27
The applicant should describe premises or locations that may be affected by the emissions	The closest sensitive receptors that may be affected by the emissions have been described and the dust effects on these receptors assessed in the *Environmental Statement*. Other sensitive receptors within 350m have also been described.	Section 4.4 and 4.5 of Vol 4-27

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
The applicant should describe measures to be employed in preventing or mitigating the emissions	Measures to prevent of mitigate dust emissions have been outlined in the Section 7 of *CoCP* Part A and Part B.	*CoCP* Part A and Part B (Section 7)
The applicant is advised to consult the relevant local planning authority and, where appropriate, the Environment Agency about the scope and methodology of the assessment	The relevant local planning authorities have been consulted through a *Scoping Report*, a Position Paper, and various consultations (phase one, phase two, interim, targeted and Section 48 consultation). It is not appropriate to consult the EA regarding the air quality and odour assessments for the project.	Vol 2 Appendix B.1

Local air quality

4.3.4 The provisions of Part IV of the Environment Act 1995 establish a national framework for air quality management, which requires all local authorities in England, Scotland and Wales to conduct local air quality reviews. Section 82(1) of the Act requires these reviews to include an assessment of the current air quality in the area and the predicted air quality in future years. Should the reviews indicate that the objectives prescribed in the *Air Quality Strategy* are not achieved, the local authority is required to designate an Air Quality Management Area (AQMA). Action must then be taken at a local level to ensure that air quality in the area improves. This process is known as 'local air quality management'.

4.3.5 The air quality objectives applicable to local air quality management (LAQM) in England are set out in the Air Quality (England) Regulations 2000 and the Air Quality (England) (Amendment) Regulations 2002.

4.3.6 The *Air Quality Framework Directive* (96/62/EC) on ambient air quality assessment and management defines the European Union (EU) policy framework for 12 air pollutants known to have a harmful effect on human health and the environment. The mandatory limit values for the pollutants were set through a series of Daughter Directives. The limit values for nitrogen dioxide (NO_2) and particulate matter (PM_{10}) were amalgamated with those for other pollutants into a new air quality directive (Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe) that came into force in June 2008, and has recently been transposed into national legislation (The Air Quality Standards Regulations 2010 SI 2010 No.1001).

4.3.7 The local air quality assessment focuses on the two main pollutants of concern: NO_2 and PM_{10}. The majority of the Thames Tideway Tunnel project sites are in AQMAs for these two pollutants. Exceedances of the other air quality objectives and limit values are considered to be very unlikely and are therefore not considered in the assessment. The only other pollutant considered is oxides of nitrogen (NO_X) which is considered solely at the Barn Elms site due to the proximity of the site access road to the Barn Elms Wetland Centre SSSI.

4.3.8 The objectives and limit values for NO_2 and PM_{10} are shown in Vol 2 Table 4.3.2. This table shows the objectives and limit values in units of microgrammes per cubic metre (µg/m^3). The table includes the number of permitted exceedances in any given year (where applicable).

Vol 2 Table 4.3.2 Air quality – Objectives/limit values – NO_X, NO_2 and PM_{10}

Pollutant	Concentration	Measured as	Date to be achieved by
Nitrogen dioxide (NO_2) objective	200µg/m^3 not to be exceeded more than 18 times a year	1-hour mean	31.12.2005
	40µg/m^3	Annual mean	31.12.2005
Nitrogen dioxide (NO_2) limit value	200µg/m^3 not to be exceeded more than 18 times a year	1-hour mean	01.01.2010
	40µg/m^3	Annual mean	01.01.2010
Particles (PM_{10}) (gravimetric) objective	50µg/m^3, not to be exceeded more than 35 times a year	24-hour mean	31.12.2004
	40µg/m^3	Annual mean	31.12.2004
Particles (PM_{10}) (gravimetric) limit value	50µg/m^3, not to be exceeded more than 35 times a year	24-hour mean	01.01.2005*
	40µg/m^3	Annual mean	01.01.2005*
Nitrogen oxides (NO_X) vegetation objective	30µg/m^3	Annual mean	19.07.2001**
Nitrogen oxides (NO_X) vegetation limit value	30µg/m^3	Annual mean	01.01.2001*

** Time extension granted for Greater London until 11.06.11*
*** Applies only to locations more than 20km from towns with more than 250,000 inhabitants or more than 5km from other built-up areas, industrial installations or motorways. The policy of the UK statutory nature conservation agencies is to apply the 30µg/m^3 criterion in internationally designated conservation sites and SSSIs on a precautionary basis.*

4.3.9 This assessment has been undertaken in line with methodologies outlined in the Defra guidance LAQM.TG(09) (Defra, 2009)[15] and the Design Manual for Roads and Bridges[16].

4.3.10 Naphthalene would be released during the handling of soils at the Earl Pumping Station site. The World Health Organisation guideline for naphthalene is 10 µg/m^3 for the annual mean.

Construction plant

4.3.11 Directive 97/68/EC (emission of gaseous and particulate pollutants from internal combustion engines to be installed in non-road mobile machinery) was first adopted in 1997. The Directive requires all engines sold for use in non-road mobile machinery in the EU to clearly demonstrate compliance with the Directives pollutant emission limits. The key driver for the Directive stemmed from an EC policy aimed at harmonising national arrangements of Member States, and in doing so removing possible trade barriers. Directive 97/68/EC has been subsequently amended by 2001/63/EC, 2002/88/EC and 2004/26/EC.

4.3.12 The Directive was transposed into UK law through the Non-Road Mobile Machinery (Emission of Gaseous and Particulate Pollutants) Regulations 1999 (Statutory Instrument No. 1999/1053), subsequently amended as shown in Vol 2 Table 4.3.3. The Regulations apply to new engines to be installed in non-road mobile machinery, intended and designed to move, or to be moved on the ground, either on or off the road.

Vol 2 Table 4.3.3 Air quality – EU directive and UK regulations amendments

Directive	Subsequent UK Regulations	Scope
97/68/EC	S.I. 1999/1053: The Non-Road Mobile Machinery (Emission of Gaseous and Particulate Pollutants) Regulations 1999	Base directive covers variable speed diesel engines.
2001/63/EC	S.I. 2002/1649: The Non-Road Mobile Machinery (Emission of Gaseous and Particulate Pollutants) (Amendment) Regulations 2002	Amendment takes account of technical progress in United Nations Economic Commission for Europe (UNECE) regulation No.96 on emissions from Agricultural and forestry tractor engines.
2002/88/EC	S.I. 2004/2034: The Non-Road Mobile Machinery (Emission of Gaseous and Particulate Pollutants) (Amendment) Regulations 2004	Amendment covers small SI engines, constant speed diesel engines, imports of used engines and secondary engines, mounted on road vehicles that are not used as the main propulsion engine.
2004/26/ EC	The Non-Road Mobile Machinery (Emission of Gaseous and Particulate	Amendment includes engines for locomotives and inland waterway vessels

Directive	Subsequent UK Regulations	Scope
	Pollutants) (Amendment) Regulations 2006	and to improve harmonization of standards and means of testing.

4.3.13 Since the Directive came into force, tighter emissions controls have been progressively applied to diesel engine machinery in various power bands between 18kW and 560kW. The relevant emissions standards are based on levels of particulate matter (PM), oxides of nitrogen (NO_X), hydrocarbons (HC) and carbon monoxide (CO). The standards vary according to equipment type and engine size. Vol 2 Table 4.3.4 below illustrates the standard for non-mobile machinery. Stage IIIA comes into force between 2006 and 2011; Stage IIIB between 2010 and 2012; and Stage IV between 2013 and 2014. Machinery less than 18kW was assumed to meet Stage IIIA limits.

Vol 2 Table 4.3.4 Air quality – EU emission directives for diesel machinery

Category	Net power (kW)	NOX (g/kWh)	PM (g/kWh)
Stage IIIA (V- variable speed, C-constant speed)			
H (V)	130 ≤ P < 560	NOX + HC: 4.0	0.2
H (C)			
I (V)	75 ≤ P < 130	NOX + HC: 4.0	0.3
I (C)			
J (V)	37 ≤ P < 75	NOX + HC: 4.7	0.4
J (C)			
K (V)	19 ≤ P < 37	NOX + HC: 7.5	0.6
K (C)			
Stage IIIB			
L	130 ≤ P < 560	2.0	0.025
M	75 ≤ P < 130	3.3	0.025
N	37 ≤ P < 75	3.3	0.025
P	19 ≤ P < 37	NOX + HC: 4.7	0.025
Stage IV			
Q	130 ≤ P < 560	0.4	0.025
R	56 ≤ P < 130	0.4	0.025

Note: for diesel fuelled non-road machinery

4.3.14 Replacement engines must meet the emissions requirements in place at the time the machinery was originally put into service.

Odour

4.3.15 Odour can be caused by a mix of chemicals in gaseous form or a single chemical. As the individual constituents of the odour may not be known, it is practical to use a descriptor that allows for this. The European odour unit (ou_E) is widely used for this purpose and describes the strength of an odour. One European odour unit ($1ou_E/m^3$) is the concentration at which half of the people on an odour panel can detect the odour. The strength of an odour in odour units is defined as the number of times a sample needs to be diluted with odour free air to reach a point at which half of the people on an odour panel can detect the odour[ii]. The odour panel sampling (olfactometry) is carried out in laboratory conditions where odours are more noticeable than in real world conditions.

4.3.16 Whether or not odour emissions cause a problem in terms of amenity or nuisance depends on a number of factors. There is no single method of reliably measuring or assessing odour pollution and any conclusion is best based on a number of pieces of evidence. The EA has produced (in odour management guidance)[17] the FIDOR acronym as a useful reminder of some of the odour factors that determine the severity of an odour. This is similar to the factors determining statutory nuisance. The acronym is explained in Vol 2 Table 4.3.5.

Vol 2 Table 4.3.5 Odour – FIDOR factors determining offensiveness

FIDOR	Comments
Frequency	How often an individual is exposed to odour. Even an odour that is inoffensive can be perceived as a nuisance if exposure is frequent. At low concentrations a rapidly fluctuating odour is more noticeable than a steady background, ie, is an aggravating factor.
Intensity	The perceived strength of the odour is proportional to concentration. The intensity is often assessed in terms of odour units. For new proposals, it can be assessed by dispersion modelling. The human nose responds to odour exposure over a one to five second interval. Average exposure levels may very well below the detection threshold but still expose people to short-term concentrations which are much higher.
Duration	The length of a particular odour event. This is mainly determined by the frequency of emissions and wind direction.
Offensiveness	Relative character. Some odours are generally regarded

[ii] The European odour unit (ou_E) is the amount of odorant that when evaporated into one cubic metre of neutral gas at standard conditions, elicits a physiological response from an odour panel equivalent to that elicited by one European Reference Odour Mass (EROM) evaporated in one cubic metre of neutral gas at standard conditions. 1 EROM is 123µg of n-butanol which produces a concentration of 40ppb. Standard CEN EN 13725:2003 describes the measurement of odour concentrations by dynamic olfactometry.

FIDOR	Comments
	as more unpleasant than others. Odour from sewage is regarded as being one of the most offensive.
Receptor	The characteristics of the neighbourhood where the odour occurs. Some receptors are more sensitive than others. Domestic residences or a pub with a beer garden are more likely to be sensitive than an industrial complex or passers-by. The more people that are exposed to the pollution, the greater is the justifiable expenditure on control measures.

4.3.17 The EA's H4 odour management guidance advises that modelling can be a useful source of predictive information to assess the likely impact of odour. The benchmark modelling method commonly used in the UK calculates a 98th percentile of hourly average odour concentrations over a year. The EA uses this benchmark and sets a concentration of $1.5ou_E/m^3$ at the site/installation boundary for the most offensive odours. This means that 2% (175 hours) of the hourly average concentrations in a year can exceed $1.5ou_E/m^3$.

4.3.18 Defra advises in its Odour Guidance for Local Authorities[18] that the odour benchmark, discussed in the paragraph above, is a useful tool to assess and control the odour impact of new developments through the planning control regime and can be a very effective means of protecting amenity and therefore preventing or controlling future statutory nuisance from odours, at the planning stage. The EA advises in its Odour Management Guidance that any modelled results that project exposures above these benchmark levels indicates the likelihood of unacceptable odour pollution.

4.3.19 Problems that were not anticipated at the planning stage can be addressed through the use of statutory nuisance. The local authority has powers and duties to address issues arising from odours through the statutory nuisance provisions of the Environmental Protection Act 1990. Statutory nuisance can be for nuisance or prejudicial to health (or both). For it to be a nuisance, interference in an average reasonable person's personal comfort is required. The FIDOR factors should be taken into account when assessing statutory odour nuisance[19]. Odours that could be a statutory nuisance include those which cause obvious and active changes in a person's behaviour, such as avoiding the use of the garden, closing windows, making complaints and keeping odour diaries. However, it also has to take account of the frequency and duration of odour events.

4.3.20 In March 2012, Defra issued the National Policy Statement (NPS) for Waste Water. This *NPS* sets out Government policy for the provision of major wastewater infrastructure. *National Policy Statements* are the primary consideration for the Planning Inspectorate when it makes decisions on applications for development consent for nationally significant infrastructure. The project is a nationally significant infrastructure project and is named in the *NPS*. The *NPS* advises that odour impacts should be assessed using appropriate odour impact standards that reflect whether the odour source is highly offensive, moderately offensive or less offensive. The EA's H4 odour management guidance sets benchmark standards for odour for three levels of offensiveness. Processes involving septic effluent or sludge are classed as highly offensive and so have the standard discussed in the paragraph above. The *NPS* states that the impact exposure standard should be applied at sensitive receptors such as housing, hospitals and schools and the effects of odour on surrounding land uses such as commercial premises, recreational facilities and open spaces should also be considered.

4.3.21 The *NPS* states that the Planning Inspectorate should satisfy itself that all reasonable steps have been taken and will be taken, to minimise any detrimental impact on amenity from odours on surrounding uses of land and development including housing, hospitals, schools, commercial premises, recreational facilities and open spaces.

4.3.22 The *NPS* advises that the following mitigation measures may be appropriate:

a. locating the main odour sources away from sensitive developments (such as housing, schools and hospitals, and other sensitive land uses including recreational facilities, commercial premises and open spaces)

b. selecting "low odour" process technologies

c. containment or enclosure of the most odorous sources on the site

d. where processes are enclosed, ventilation should be provided and vented, at high enough extraction rates to control fugitive leaks, to suitable odour abatement equipment

e. an *Air Management Plan* (*AMP*) documenting the measures to be employed by the site operator to anticipate the formation of odours and to control their release from the site. This should include provision and obligations for suitable monitoring and testing regimes to ensure that controls are properly maintained throughout the life of the development.

4.3.23 The impact of the project on odour has been assessed using dispersion modelling following the methodology described in Section 4.5. Management of odour has been described in the *Air Management Plan* which accompanies the application.

4.3.24 Naphthalene is expected to be released during the handling of soils at the Earl Pumping Station site and has been used as an indicator of odour. Naphthalene has an odour threshold set by the US Environmental Protection Agency of $440 \mu g/m^3$ which equals $1 ou_E/m^3$.

Oxides of nitrogen (NO_X) and nitrogen dioxide (NO_2)

4.3.25 Oxides of nitrogen (NO_X) comprise of nitric oxide (NO) and nitrogen dioxide (NO_2). Estimates for 2010 (AEA Technology, 2012)[20] show that the transport sector accounted for 33% of the total UK emissions of NO_X, with the energy industry being another major source. In central London, road transport contributes a significant proportion of NO_X emissions, estimated at 46% in Greater London and 60% in central London in 2008 (Greater London Authority, 2010)[21].

4.3.26 The majority of NO_X emitted from vehicles is in the form of NO, which is oxidised in air to produce NO_2. The conversion of NO to NO_2 takes place via reactions with chemically active air pollutants, such as ozone. NO_2 has the potential to affect human health. The UK air quality objective and EU limit value for NO_2 is detailed in Vol 2 Table 4.3.2.

Particulate matter

4.3.27 Particulate matter comprises of a wide range of materials arising from a variety of sources. It is any solid matter. Particulate matter is typically assessed as total suspended particulates or as a mass size fraction. The larger particles tend to settle out near the source whilst the fine particles can travel large distances.

4.3.28 PM_{10} is a mass fraction of airborne particles of aerodynamic diameter of 10µm or less. The Air Quality Standards Regulations 2007 adopted the PM_{10} standard for assessing fine particulate matter. This standard expresses the particulates as the total mass size fraction at or below an aerodynamic diameter of 10µm. Particles of this size have the greatest likelihood of reaching the lung and so have the potential to affect human health. The UK air quality objective and EU limit value for PM_{10} is detailed in Vol 2 Table 4.3.2.

4.3.29 Road transport, production processes and commercial and residential combustion were the main sources of PM_{10} in 2010. In central London, road transport is the major source, contributing 79% of PM_{10} emissions in 2008.

Dust

4.3.30 Construction activities can lead to dust emissions. In terms of human and ecological health/nuisance impacts, these can be categorised as particulate matter (PM_{10}) and dust, depending upon their size.

4.3.31 Dust is defined in the IAQM guidance (Institute of Air Quality Management, 2012)[22] as all particulate matter, ie, total suspended particles comprising both suspended and deposited dust, whereas PM_{10} is a mass fraction of airborne particles of diameter of 10µm or less. The health impacts associated with PM_{10} include eye, nose and throat irritation; dust nuisance is caused by deposition on cars, windows and property. Dust and PM_{10} emissions arise from a number of sources, so both construction activities and emissions from vehicles associated with the construction site need to be considered.

Construction related volatile contaminant emissions

4.3.32 The soils at the Earl Pumping Station site are contaminated with a number of volatile contaminants such as xylenes, ethylbenzene and various other benzene related compounds. However, the principal contaminant is the polycyclic aromatic hydrocarbon (PAH) compound naphthalene. Naphthalene is the most volatile PAH compound. Naphthalene has been identified as the PAH most likely to be an issue during the construction phase.

4.3.33 Naphthalene has been assessed for health impact (air quality) and odour. The vapor has a sharp, pungent odour that is irritating to the eyes and upper respiratory tract. Inhalation of high concentrations causes headache, dizziness, nausea, and vomiting. Naphthalene has been classified by the International Agency for Research on Cancer as “possibly carcinogenic to humans”.

4.4 Baseline data collection

4.4.1 This section describes the baseline data, both desk and field based sources, collected for the air quality and odour assessments.

4.4.2 The baseline year for the local air quality study has been taken to be 2010. The year 2011 has not been used as the baseline year because preliminary data suggest that air pollutant concentrations were significantly lower in 2011 than in previous years (of the order of 10% lower than 2010 concentrations). These reduced concentrations are most likely to have been caused by unusual regional meteorological events during 2011. Therefore, in order to ensure that the methodology is robust and appropriate, the more typical concentrations measured in 2010 have been used as the baseline for the assessment.

Desk based baseline data

Local air quality

4.4.3 The local air quality assessment requires the collection of existing local monitoring data.

4.4.4 Monitoring data for nitrogen dioxide (NO_2) and particulate matter (PM_{10}) have been collected from local authorities. These data have been sourced through direct consultation, local authority websites and the London Air Quality Network (LAQN)[23]. These data have been collected for the last five years (where available) to provide an indication of historical trends at each monitoring site. The 2010 data were used for the verification of the modelling work for the local air quality assessment for the construction phase.

4.4.5 In addition, local authority review and assessment reports have been reviewed in relation to each site. This work provides a context for the baseline situation by detailing the major sources of air pollution located within the local authorities’ boundaries. These reports also indicate local trends in air quality, the progress that a local authority is making with regard to their air quality action plans and any proposed new developments which may impact on air quality.

4.4.6 Background concentration data for NO_X, NO_2 and PM_{10} have also been collected from the air quality section of the Defra website (Defra, 2012)[24]. These data have been used in conjunction with local monitoring to provide background concentrations for the modelling.

4.4.7 Sensitive receptors for the assessment have been selected on a site-specific basis and have been presented as part of the baseline for each site.

Construction dust

4.4.8 Receptors have also been selected for the purposes of the construction dust assessment.

Odour

4.4.9 The principal baseline data for the odour assessment are qualitative odour complaint data in the vicinity of the sites. These data indicate whether there are existing odour issues in the vicinity of any of the sites that warrant further investigation to identify potential sources.

4.4.10 Odour complaints for the area in the vicinity of each site have been collected from the local authorities. In addition, complaints registered with Thames Water have been collated.

4.4.11 As part of the baseline data collection, receptors have also been identified for the odour assessment.

Field survey baseline data

Local air quality

4.4.12 In addition to the monitoring undertaken by the local authorities as part of their duties under the local air quality management regime, baseline monitoring has been established at all the proposed project sites. This is required to provide sufficient data for the verification[iii] of the modelling work for the local air quality assessment for the construction phase. The locations of the monitoring sites have been included in the site-specific assessment volumes (Vol 4 to 27). The monitoring has employed diffusion tubes to measure monthly mean NO_2 concentrations. Triplicate tubes have been established next to a continuous monitoring station in Putney (site PEFM4 – see Vol 7) for bias adjustment purposes and at one location near each site for increased precision. At the majority of sites this monitoring started in April/May 2011.

4.4.13 At some sites, data capture has been less than 90% due to tubes being lost / vandalised. Where this is the case, following bias adjustment using the co-located diffusion tubes, these results have been seasonally adjusted to estimate annual mean NO_2 concentrations. Mean concentrations, for the period covered by the diffusion tubes, and annual mean concentrations 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 have been used to calculate the seasonal adjustment

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

factor, which has then been applied to the monitoring sites where it has not been possible to collect a full year's worth of monitoring data.

4.4.14 At all monitoring sites established for this assessment, a similar method to that described in para. 4.4.13 has been applied to estimate annual mean NO_2 concentrations for 2010. Mean concentrations for the period covered by the diffusion tube monitoring (April 2011 to April 2012) and annual mean NO_2 concentrations for 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 April 2011 to April 2012 period mean NO_2 concentrations and 2010 annual mean NO_2 concentrations have been used to determine an adjustment factor, which has then been applied to the diffusion tube monitoring data to provide estimates of annual mean NO_2 concentrations at those locations.

Construction dust

4.4.15 Monitoring of background dust levels and particulates would be undertaken in the year prior to any construction activity to provide a baseline. This monitoring would last for 12 months. Subsequent particulate and dust monitoring would then be undertaken during the construction period using the same methodology.

4.4.16 The methodology for this monitoring would be in accordance with the GLA Best Practice Guidance and the latest IAQM guidance on monitoring near construction sites. A baseline would be established prior to construction using appropriate particulate monitoring techniques. This monitoring would continue during construction until the site is deemed to be low risk. All sites would have passive deposition monitoring techniques adopted at appropriate locations. At relevant sites an alert system would be operated based on predetermined site action levels.

Odour

4.4.17 Baseline monitoring of H_2S has been carried out by Thames Water to give an indication of concentrations at each site. Spot measurements were carried out in August 2011, October 2011, December 2011, February 2012, May 2012 and August 2012. The measurements were made using a Jerome J605 analyser. The meteorological conditions were noted at the time of the surveys.

Receptor identification and sensitivity

Local air quality

4.4.18 Selected receptors can be ranked in terms of their sensitivity based on the exposure and vulnerability of the receptor.

4.4.19 The sensitivity of the selected receptors for the assessment has been based on Defra guidance LAQM.TG(09) which uses the criteria detailed in Vol 2 Table 4.4.1. The receptors closest to the construction areas of each type have been selected for each site assessment. Receptors at new developments have also been selected for assessment, where appropriate.

Vol 2 Table 4.4.1 Air quality – local air quality receptor sensitivity criteria

Receptor value and/or sensitivity	Definition
High	Residential properties, hospitals and clinics, retirement homes, schools, care homes, designated ecological sites
Medium	Hotels, gardens of residential properties, vegetation, parks, playgrounds (includes school playgrounds and playing fields), places of worship, libraries, community facilities
Low	Busy pedestrian areas such as shopping areas, river locations, riverside locations accessible by the public, unenclosed areas of bus and rail stations, restaurants, cafes, public houses, shops, offices, industrial areas

Construction dust

4.4.20 In accordance with the IAQM guidance, the closest receptors within 350m of the construction sites have been identified.

4.4.21 In determining the sensitivity/value of receptors, consideration was given to the dust sensitive receptor listings detailed in Vol 2 Table 4.4.2. The sensitivity of these receptors has been taken from Minerals Planning Statement and the IAQM guidance.

Vol 2 Table 4.4.2 Air quality – construction dust receptor sensitivity criteria

Receptor value and/or sensitivity	Definition
High	Hospitals and clinics, retirement homes, hi-tech industries, painting, furnishing, food processing, vehicle showrooms, European designated ecological sites
Medium	Food retailers, schools, residential properties, parks, playgrounds, hotels, greenhouses and nurseries, horticultural land, offices, vegetation, places of worship, public houses, river locations, riverside locations accessible by the public, nationally designated ecological sites
Low	Farms, light and heavy industry, outdoor storage, locally designated ecological sites

4.4.22 In considering receptor sensitivity, it is important to appreciate the key difference between dust and air pollution. Essentially, dust pollution is a nuisance based issue, whereas air pollution is a health based issue. The same receptors are therefore not be equally sensitive to both. For example, residential receptors are considered high sensitivity for air quality but medium sensitivity for dust, as residential receptors are health sensitive. Conversely, food manufacturing premises are considered high sensitivity for dust but low for air quality, given the nuisance dust sensitive nature of the sector. Furthermore, the occupational nature of a food manufacturing receptor is not covered within the UK Air Quality Strategy and hence is considered to be of low sensitivity.

Odour

4.4.23 Relevant receptors for the odour assessment have also been identified and their sensitivity determined using the criteria detailed in Vol 2 Table 4.4.3. The odour benchmark has been applied in areas where people are likely to be exposed such as residential properties, schools and hospitals. These types of properties are deemed to be of high sensitivity. Medium sensitivity receptors would be areas where people are likely to be exposed over short periods such as recreational areas or in the workplace. Low sensitivity receptors would be in areas where there is infrequent human exposure such as footpaths and roads.

Vol 2 Table 4.4.3 Odour – receptor sensitivity criteria

Receptor value and/or sensitivity	Definition
High	Residential properties, pubs/restaurants/hotels, schools, school playgrounds/playing fields, hospitals
Medium	Industrial or commercial workplaces, recreational areas, places of worship
Low	Areas where individuals are exposed for a very short period of time such as footpaths and roads

Note: Adapted from EA's Odour Management and NPS on Waste Water

Base case

4.4.24 The base case has been derived from the baseline (2010) taking account of how the air quality environment may change due to modifications in the sources of air pollution. For example, for road vehicles, there will be change in the penetration of new Euro standards to the fleet composition between the current situation and the base case meaning that tougher Euro standards will result in emissions decreasing with time. Additionally, background air pollution concentrations will reduce due to local and national policies.

4.4.25 The base case also takes into account future developments in the vicinity of the sites, which are likely to be completed in the peak construction year for the construction phase assessment. The future developments have been identified as those developments from the site development schedules (see Appendix N in Vols 4-27), which are within the local air quality and odour assessment areas.

4.5 Construction effects assessment

4.5.1 This section describes the methodology for the assessment of local air quality effects during construction and construction dust effects. This includes the identification of assessment years, assessment areas, methodology and significance criteria used.

4.5.2 This section also describes the methodology for the assessment of pollution/odour from contaminated land during construction at the Earl Pumping Station site.

Assessment years

Local air quality

4.5.3 The assessment year is the peak construction year for each site which for air quality is taken as the year when annual construction traffic movements would be at a maximum. For the identified peak year, the base case has been assessed including all appropriate emission sources without the Thames Tideway Tunnel project.

4.5.4 The development case has then been assessed in the same peak construction year including the Thames Tideway Tunnel project.

4.5.5 The assessment therefore considers the ‘development case’ compared with the ‘base case’ in a particular assessment year. A comparison of the two different scenarios for the assessment year provides a measure of the effect of the Thames Tideway Tunnel project on local air quality.

4.5.6 In addition, consideration is given to the extent to which the construction assessment findings would be likely to vary materially from those assessed should the programme for the Thames Tideway Tunnel project be delayed by approximately one year.

Construction dust

4.5.7 The construction dust assessment does not focus on any particular assessment year, but deals with the potential sources of dust holistically over the duration of the construction works.

4.5.8 As the assessment is not year specific, the construction dust assessment findings would be unchanged by any programme delay. No further consideration of this is therefore necessary.

Construction related volatile contaminant emissions

4.5.9 The construction related volatile contaminant emissions assessment for Earl Pumping Station focuses on the year with the greatest volume of soil being handled as this would result in the largest volume of contaminants volatilising into the air. This is therefore the year used for the assessment of pollution/odour from contaminated land.

4.5.10 A programme delay of one year would not affect the magnitude and significance of effects identified but just occur one year later. No further consideration of this is therefore necessary.

Assessment areas

Local air quality

4.5.11 The assessment areas are site-specific (defined in Vol 4 to 27). For local air quality, the assessment areas are primarily driven by the extent of roads that are significantly affected by the proposed construction traffic from the site. As a minimum, the assessment area extends up to 200m from the site boundary.

Construction dust

4.5.12 Sensitive receptors closest to the dust generating processes (within 350m) have been identified for the assessment.

Construction related volatile contaminant emissions

4.5.13 Sensitive receptors closest to the soil handling activities (within 350m) have been identified for the assessment.

Methodology

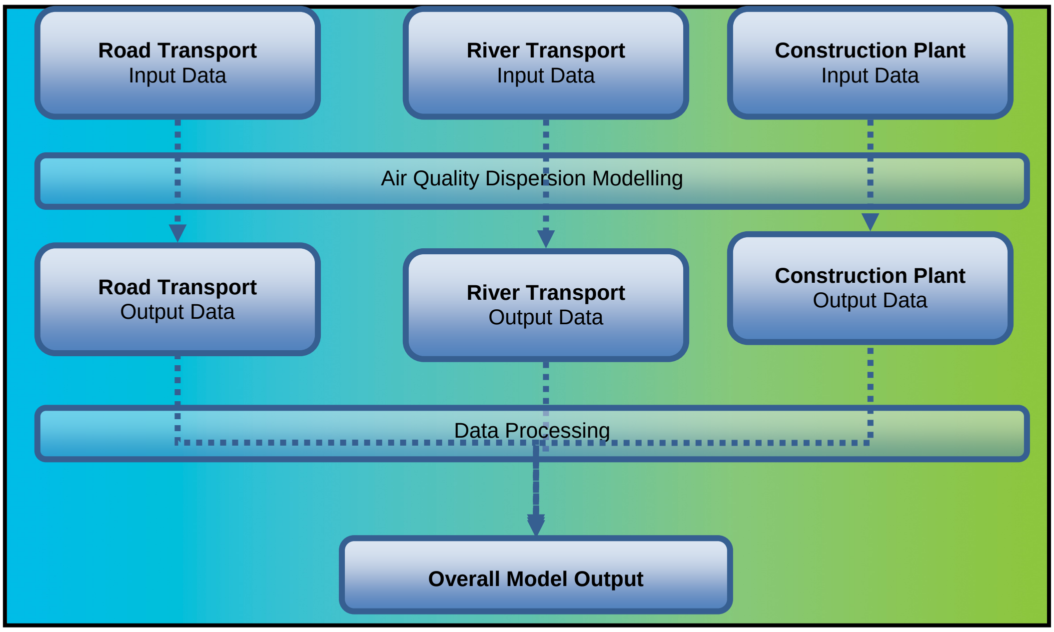
Local air quality

4.5.14 Generically, the effects from construction on local air quality would be on pollutant concentrations of NO_X, NO_2 and PM_{10} from construction traffic, from tugs pulling river barges (for the sites where materials are delivered or taken away via the river) and construction plant. These emission sources could also affect the deposition of nitrogen to the Barn Elms Wetland Centre SSSI which is therefore also considered in the assessment for the Barn Elms site.

4.5.15 The assessment has involved separate modelling studies for road transport, tugs for river barges (where applicable) and construction plant. The results from these separate modelling exercises have then been amalgamated to give an overall output.

4.5.16 A flow diagram of the modelling process is in Vol 2 Plate 4.5.1.

Vol 2 Plate 4.5.1 Air quality – modelling process



Assessment of emissions from road transport

Model overview

4.5.17 Construction traffic from the project may have an effect on local air quality through the movement of heavy good vehicles (HGVs) and light goods vehicles (LGVs) transporting materials to and from the sites. At some sites there would also be some traffic movements associated with workers' cars.

4.5.18 The effects of these movements on local air quality have been modelled using the regional dispersion model AAQuIRE (version 6.2). Concentrations of NO_2 and PM_{10} arising from road traffic sources have been predicted at receptors across the assessment area using the AAQuIRE model which has been used widely for the past 17 years. The model uses the dispersion algorithm, CALINE4, which has been independently and extensively validated.

4.5.19 With regard to the assessment of NO_X concentrations and nitrogen deposition at the Barn Elms Wetland Centre SSSI, NO_X concentrations due to road traffic sources have also been predicted using the AAQuIRE model. Nitrogen deposition has then been derived from the predicted NO_2 concentrations using the DMRB methodology.

Road transport emissions

4.5.20 For road vehicles, emission factors and fleet compositions have been taken from the latest Defra emission factors toolkit (Defra, 2012)[25]. In the future, there will be a change in the fleet composition due to the penetration of new Euro standards. The uptake of newer vehicles with improved emission controls should lead to a reduction in existing NO_2 and PM_{10} concentrations.

4.5.21 Traffic data are based on the figures contained in the *Transport Strategy*. The traffic data include Annual Average Daily Traffic (AADT) flows, heavy goods vehicles (HGV) proportions and speeds for each road link assessed. The traffic data have taken account of the impacts of all the project sites on any particular road.

4.5.22 A sensitivity test of the *Transport Strategy* figures has also been undertaken which is contained in Vol 3 Appendix J.

Background concentrations

4.5.23 A large number of small sources of air pollutants exist, which individually may not be significant, but collectively over a large area need to be considered in the modelling process. The emissions from these background sources have been applied to the model as background concentrations. In this assessment, pollutant contributions from all sources other than the modelled road traffic sources have been included as background concentrations.

4.5.24 The primary source of background pollutant concentrations is the Defra estimated national background maps. Mapped background pollutant concentrations are available for each 1km by 1km grid square within every local authority’s administrative area for each year from 2010 to 2030, inclusive. For each assessment area the mapped background pollutant concentrations for nearby 1km grid squares have been considered alongside local urban background monitoring data (where available) to determine the most representative background concentrations to be used in the assessment. Having obtained appropriate background concentrations for the baseline modelling year (2010) the same grid square or local monitoring site has been selected to determine background concentrations for the peak construction year.

4.5.25 To avoid double counting of road traffic sources the contribution to background pollutant concentrations from motorways, trunk roads and primary A roads within each grid square have been subtracted from the total background concentrations for NO_X and PM_{10}. Adjusted background NO_2 concentrations have been obtained using the NO_2 adjustment for NO_X sector removal tool in accordance with the methodology outlined in LAQM.TG(09). Local monitoring data have been used as the source of the background concentration only when the site is a true background site and therefore has not needed to be adjusted for double-counting.

4.5.26 The background deposition rate in the 5km by 5km square containing the Barn Elms Wetland Centre SSSI has been taken from the APIS website (Air Pollution Information System, 2012)[26]. The critical load for deposition of nitrogen has also been obtained from this website.

Meteorological data

4.5.27 Meteorological data from 2010 have been used for the local air quality assessment. For all the sites, these meteorological data have been taken from Heathrow Airport as this has the most complete and longest running historical dataset in the area. Meteorology is affected by ground surface conditions so the surrounding land is characterised in terms of surface roughness, stability class and mixing height. The surface roughness length used was 1m. Meteorological data for 2010 have been used for the modelling in accordance with Defra guidance, which recommends that the meteorological data, background data and emissions data are derived for the same year. A sensitivity analysis has however been undertaken for the Greenwich Pumping Station site with meteorological data taken from London City Airport (in line with good practice) – this is contained in Vol 2 Appendix B.2.

Conversion of NO_X to NO_2

4.5.28 The proportion of NO_2 in NO_X varies greatly with location and time according to a number of factors including the amount of ozone available and the distance from the emission source.

4.5.29 The Air Quality Expert Group (AQEG) (AQEG, 2004)[27] reported that urban NO_X concentrations had declined since the early 1990s as a result of decreasing road traffic emissions, but corresponding decreases in NO_2 had not been observed, resulting in an increase in the NO_2/NO_X ratio. The magnitude of the increase was inconsistent with the increase expected solely as a consequence of reduced NO_X concentrations. The findings were supported by monitoring data from a number of locations in London and AURN data from across the UK. These observations prompted research into the NO_2/NO_X relationship and an updated version of the relationship was published (Air Quality Consultants, 2006)[28].

4.5.30 The NO_X from NO_2 calculator spreadsheet (Defra, 2012)x[29], provided by AEA Technology on behalf of Defra provides a revised methodology for converting NO_X to NO_2 for any given year where NO_X is predicted by modelling road traffic emissions. The calculator can also be used to derive the road component of NO_X from roadside NO_2 diffusion tube measurements. It incorporates the impact of expected changes in the fraction of NO_X emitted as primary NO_2 and changes in regional concentrations of NO_X, NO_2 and ozone (O_3).

4.5.31 The NO_X from NO_2 calculator has been used in the assessment for all scenarios as the best representation of the NO_2/NO_X relationship. The calculator was run for each assessment year and local authority area using the “UK Traffic” traffic mix option to represent emissions from road transport, river transport and construction plant.

4.5.32 More recent studies (Grice *et al*., 2009)[30] also confirmed that primary NO_2 has increased in many locations in the UK and Europe because of changes in the vehicle fleets composition and the introduction of vehicle emission technologies that have been fitted to meet emission limits for pollutants. Primary NO_2 is predicted to increase until 2015 and then decline by 2020. This increase is dealt with by the NO_X to NO_2 calculator (Defra, 2012).

Model outputs

4.5.33 The effects of the Thames Tideway Tunnel project on local air quality have been assessed by predicting annual mean concentrations of NO_X, NO_2 and PM_{10}. Discussion of the likely effects on the 1-hour mean NO_2 concentration and the daily mean PM_{10} concentration has also been undertaken using the relationships between annual mean and peak concentrations in the Defra guidance LAQM.TG(09) (Defra, 2009) to assess whether shorter-term peak criteria are likely to be exceeded.

4.5.34 At receptors where significant impacts have been predicted solely with respect to the hourly NO_2 objective, based on the relationship between annual mean and 1-hour concentrations as described above, further modelling of hourly concentrations has been undertaken. This modelling has focussed on the emissions from construction plant, as in all cases the plant is the predominant source of NO_X emissions. This modelling has been undertaken using hourly sequential meteorological data to predict NO_X concentrations for each hour of the year for the construction plant. This hourly contribution was then added to NO_X concentration at the closest roadside site for each hour of the year. In this way, a more accurate prediction was obtained for whether or not there was an exceedance of the hourly objective.

4.5.35 The modelling procedure adopted predicted annual mean NO_2 and PM_{10} concentrations at receptors covering the assessment area using a Cartesian grid of receptors at a height of 1.5m above ground level to simulate human exposure. These receptors were evenly spaced at 10m intervals to ensure that a high level of spatial resolution was obtained. The results produced allow the generation of NO_2 and PM_{10} concentration contours. Pollutant concentrations have also been predicted at specific sensitive receptors. These receptors were selected using professional judgement and through consultation with the relevant local authorities.

4.5.36 These specific sensitive receptors included the Barn Elms Wetland Centre SSSI (at the Barn Elms site only) at which annual mean NO_X concentrations and nitrogen deposition levels have been predicted in a transect up to 200m from the nearest emission sources of NO_X.

Model verification

4.5.37 For the detailed dispersion modelling assessment, it is necessary to consider and account for random errors in both the modelling and the monitoring data.

4.5.38 The predicted results from a dispersion model may differ from measured concentrations for a number of reasons, including:

a. estimates of background concentrations

b. meteorological data uncertainties

c. uncertainties in source activity data such as traffic flows, stack emissions and emissions factors

d. model input parameters such as roughness length

e. uncertainties associated with monitoring data, including locations.

4.5.39 Model verification is the process by which model performance is assessed at the local level. The verification process involves a comparison between predicted and measured pollutant concentrations at one or more suitable local sites. In particular, the verification of road traffic modelling considers the predicted versus measured “road traffic contribution” to concentrations, so that the model performance can be adequately assessed.

4.5.40 NO_X concentrations modelled using the AAQuIRE model have been verified against local continuous monitoring and diffusion tube sites located within each of the site assessment areas. In accordance with LAQM.TG(09), the initial step of model verification was carried out for NO_X concentrations.

4.5.41 A ratio between modelled and monitored road traffic NO_X concentrations was obtained by plotting modelled and monitored NO_X concentrations against one another and performing linear regression on the data. Following checks of the model input data and further refinement where appropriate (eg, reduction of vehicle speeds near junctions and areas of congestion, selection of background concentration), a factor F (from the slope of linear regression equation) has been calculated.

4.5.42 All modelled road traffic NO_X contributions were adjusted by the factor F to obtain adjusted modelled road traffic NO_X concentrations. The adjusted modelled NO_X contributions were compared against monitored concentrations to ensure good agreement.

4.5.43 Adjusted road traffic NO_X concentrations were then converted to modelled NO_2 concentrations using the method described in para. 4.5.29. Modelled NO_2 concentrations were also compared against monitored NO_2 concentrations to determine whether secondary adjustment of NO_2 concentrations was necessary.

4.5.44 PM_{10} concentrations modelled using the AAQuIRE model have also been verified against local continuous monitoring sites located within each of the assessment areas, where possible. In accordance with LAQM.TG(09), an adjustment factor was derived from the linear regression of modelled road traffic PM_{10} concentrations and monitored road traffic PM_{10} concentrations. Model input data were checked and further refinement of the model (eg, reduction of vehicle speeds near junctions and areas of congestion, selection of background concentration) undertaken where appropriate, to optimise the model output. Where local PM_{10} monitoring data were not available, the NO_X adjustment factor has been used as outlined in Defra guidance LAQM.TG(09).

4.5.45 An adjustment factor, F taken from the linear regression equation, was applied to all modelled road traffic PM_{10} concentrations to calculate adjusted road traffic concentrations. Mapped background PM_{10} concentrations were subsequently added to the adjusted modelled values to derive total modelled PM_{10} concentrations, which were then compared against monitored concentrations to ensure a good agreement.

4.5.46 The full verification process undertaken at each site is set out as an air quality Appendix B.1 in Vol 4-27.

Assessment of emissions from river transport

4.5.47 An air quality assessment of tug emissions has been undertaken for sites that would use river transport for the import and/or export of materials.

4.5.48 The emissions from tugs (for river barges) have been modelled as area sources due to the uncertainty over the point of emission. These sources have been modelled using the US Environment Protection Agency’s (EPA) preferred regulatory model, AERMOD. AERMOD version 12060 has been used for this assessment.

4.5.49 Data regarding the tugs and their operation were collated. Input data used included the number of tugs per day, the movement of these tugs and the time spent manoeuvring and docked.

4.5.50 In order to convert from these units to units applicable to dispersion modelling, the following information relating to the tugs and their activity was required:

a. the average power output of each tug representative of the fleet likely to be used

b. the engine type used by each tug representative of the fleet to be used

c. fuel type(s) used by the tugs

d. an estimate of operational hours in a given time period, eg, per year.

4.5.51 Pollutant emissions from tugs were modelled using emission factors sourced from the European Monitoring and Evaluation Program (EMEP) *Corinair Pollutant Emissions Inventory Guidebook* (EMEP, 2011)[31]. Chapter 1.A.3.d provides guidance on estimating emissions from navigation and outlines emission factors for domestic navigation and inland goods carrying vessels (Snap Code 080304).

4.5.52 Emission factors are given based on mass of pollutant emitted per unit mass of fuel consumed. Fuel consumption figures were also reviewed if available so that emission factors could be estimated by this method in the absence of more detailed information.

4.5.53 In the absence of sufficiently detailed input data, EMEP Corinair outlines a simplified methodology using emission factors based on an assumed fleet average technology, which was adapted where appropriate for application in this modelling.

4.5.54 The same background concentrations as employed for road transport have been used for the modelling of tugs for river barges (see paras. 4.5.22-4.5.25).

4.5.55 As for the assessment of road transport, the meteorological data used for the assessment of tugs for river barges were Heathrow Airport 2010 data. Meteorology is affected by ground surface conditions so the surrounding land is characterised in terms of surface roughness, Bowen ratio and albedo for each season. The surface roughness length used was 1m. The meteorological file for use in AERMOD was prepared using the processor AERMET. The urban option was selected in AERMOD to take account of the extra heat in the city compared with rural areas that can affect the stability of the atmosphere.

4.5.56 The methodology for the NO_X to NO_2 conversion employed for the road transport assessment has been used for the assessment of tugs for river barges (see paras. 4.5.27-4.5.31).

4.5.57 Also, the effects of the Thames Tideway Tunnel project from river barges have been assessed in the same way as for road transport assessing the same pollutants / averaging periods and receptors (see paras. 4.5.32-4.5.34).

4.5.58 Model verification was not possible for the assessment of emissions from tugs given that there are currently no significant tug operations at the sites against which the model can be verified.

Assessment of emissions from construction plant

4.5.59 Emissions from the various construction plant for each site have been modelled using the US EPA dispersion model AERMOD.

4.5.60 There are a number of items of plant that may produce emissions that could affect local air quality. This plant includes:

a. excavators
b. generators
c. compressors
d. cranes
e. dumpers
f. pumps
g. fuel bowsers
h. welders
i. jack-up barges
j. ventilation fans.

4.5.61 The proposed construction plant for each of the construction sites used in the modelling are as described in Section 3 of Vol 4 to 27. For each site a schedule was provided which lists the type of all proposed plant (with descriptions) to be used at each stage of the construction process. This is included as an air quality Appendix B.3 in Vol 4-27.

4.5.62 The British Standard document BS 5228-1-2009 Part 1: Noise (BSI British Standards, 2009)[32] defines the power ratings in kW for the listed construction plant, a required input for calculating the emission factors used in the AERMOD air quality model.

4.5.63 Appropriate emission factors were assigned to each item of plant and the effects of the plant on local air quality predicted dependent upon the duration of operation.

4.5.64 The base emission factors used for the construction plant equipment are those set out in the EMEP/EEA Guidebook. Whilst not providing equipment specific factors, the Guidebook does provide indicative factors relating to equipment power range.

4.5.65 In order to take into account the change of emissions with age, degradation factors as shown in the Guidebook for diesel machinery were applied where relevant.

4.5.66 Section 3 of Vol 4 to 27 describes the proposed phasing of the construction at each site. This information, along with that provided in the plant schedules (Vols 4 to 27, Appendix N), was used to estimate the likely on-time duration of the various listed construction plant throughout the defined construction phases. This assessment then allowed the likely total emissions associated with the various construction plant from the construction process as a whole to be determined.

4.5.67 The same background concentrations employed for road transport sources have been used for the assessment of construction plant (see paras. 4.5.22-4.5.25).

4.5.68 Meteorological data from Heathrow Airport (for 2010) have again been used for the assessment of construction plant using the same AERMOD model parameters as described in para. 4.5.54.

4.5.69 The methodology for the NO_X to NO_2 conversion employed for the road transport assessment has been used for the assessment of construction plant (see paras. 4.5.27-4.5.31).

4.5.70 The effects of the Thames Tideway Tunnel project from construction plant have been assessed in the same way as for road transport (see paras. 4.5.32-4.5.34), predicting NO_2 and PM_{10} concentrations for short- and long-term averaging periods over a receptor grid and at specified sensitive receptors.

4.5.71 Model verification has not been possible for construction plant emissions given that construction plant is not present in the baseline against which the model can be verified.

Construction dust

4.5.72 As is standard practice in UK environmental assessment, construction dust has been assessed qualitatively. It is required by IAQM guidance that the following activities are assessed:

a. demolition

b. earthworks

c. construction

d. trackout.

4.5.73 These activities have been assessed at each of the Thames Tideway Tunnel project sites with reference to their scale and duration and the proximity and number of sensitivity of local receptors as described in paras. 4.5.85-4.5.86 and 4.5.94-4.5.96. Where there are project sites within 350m of each other, professional judgement has been used to determine whether the sensitivity of the surrounding area should be increased to reflect the potential for elevated effects.

Construction related volatile contaminant emissions

4.5.74 The contaminated soils at the Earl Pumping Station site contain a range of toxic substances including polycyclic aromatic hydrocarbons, some of which are carcinogenic and odorous. Naphthalene is a polycyclic aromatic hydrocarbon and has been assessed for health impacts and odour as it is present at the Earl Pumping Station site at elevated concentrations, is volatile and is odorous.

4.5.75 Emission rates of naphthalene have been calculated by the contaminated land specialists (see Section 8 of Vol 4 to 27) on an annual average basis for the health based guideline and on an hourly average basis using peak emission rates for odour. Pessimistic assumptions have been used for both estimates.

4.5.76 The emission rates of naphthalene have been estimated according to the USEPA methodology and takes into account construction phasing data, the amount of organic carbon in the soil, soil bulk density, volumetric water and air content in the soil, soil handling volumes and soil concentration data.

4.5.77 Emissions released through soil handling were set up as an area source in the model AERMOD. Meteorological data from Heathrow 2010 have been used in the dispersion modelling, again using the same model parameters as described in para. 4.5.54. Concentrations have been predicted over the assessment area using a Cartesian grid of receptors at a height of 1.5m above ground level to simulate human exposure. These receptors were evenly spaced at 10m intervals to ensure that a high level of spatial resolution was obtained. Concentrations have also been predicted at the receptors selected for the air quality and odour assessments.

Significance criteria

4.5.78 Having separately assessed emissions from road transport, tugs for river barges (where applicable) and construction plant to determine the effect on local air quality, the significance of effects associated with the combined results these has been assessed using the approach described below.

4.5.79 According to EPUK guidance[33], there are two main aspects which need to be taken into account when determining significance. These are:

a. the magnitude of the change

b. the absolute concentration in relation to air quality objectives/limit values.

4.5.80 Local air quality effects of a proposed development may be considered to be significant if air quality objectives or limit values are predicted to be breached or if the development leads to material impacts on air quality at sensitive receptors.

4.5.81 For the assessment of the effects of NO_X and nitrogen deposition at the Barn Elms Wetland Centre SSSI, there are no statutory guidelines for significance, but Natural England and the EA commonly use a 1% threshold for determining whether an effect is significant (EA, 2012)[34].

4.5.82 With regard to construction dust, the significance of effects is determined by considering the magnitude of impacts in the context of the sensitivity of the area. This is in accordance with the IAQM Best Practice Guidance.

4.5.83 For the assessment of naphthalene from construction related volatile contaminant emissions, two aspects have been considered: local air quality effects ; and the odour effects. The significance of the local air quality effects is determined using the EPUK guidance. The significance of the odour effects of naphthalene is determined against the EA's benchmark for odour, which is the 98th percentile of hourly values.

Determining magnitude of impacts

Local air quality

4.5.84 For local air quality the magnitude of change at modelled receptors is determined by the absolute change in pollutant concentrations between the base and development cases as shown in Vol 2 Table 4.5.1.

Vol 2 Table 4.5.1 Air quality – local air quality assessment magnitude of change

Magnitude of change	Annual mean NO_2/PM_{10}	Number of days PM_{10} above 50µg/m3
Large	Increase / decrease > 4µg/m^3	Increase / decrease > 4 days
Medium	Increase / decrease 2-4µg/m^3	Increase / decrease 2-4 days
Small	Increase / decrease 0.4-2µg/m^3	Increase / decrease 1-2 days
Negligible	Increase / decrease < 0.4µg/m^3	Increase / decrease < 1 day

4.5.85 A similar approach has been used for the assessment of the effects of NO_X and nitrogen deposition at the Barn Elms Wetland Centre SSSI using the percentage effects outlined in the EPUK guidance. The magnitude of change has been identified using the criteria shown in Vol 2 Table 4.5.2.

Vol 2 Table 4.5.2 Air quality – ecosystems assessment magnitude of change

Magnitude of change	Annual mean NO_X	Nitrogen deposition
Large	Increase / decrease > 3µg/m^3	Increase / decrease > 10%
Medium	Increase / decrease 1.5-3µg/m^3	Increase / decrease 5%-10%
Small	Increase / decrease 0.3-1.5µg/m^3	Increase / decrease 1%-5%
Negligible	Increase / decrease <0.3µg/m^3	Increase / decrease < 1%

Construction dust

4.5.86 In line with the IAQM Best Practice Guidance, the assessment has categorised each of the four activities (demolition, earthworks, construction and trackout) at each site into one of three potential dust emission classes:

a. large

b. medium

c. small.

4.5.87 The assessment criteria take into consideration the scale of the activity and the potential of the processes on-site to generate dust. The emission classes were determined for each activity based on the criteria given in Vol 2 Table 4.5.3. Professional judgement has been used in conjunction with these criteria to determine the dust emission class given for each category. If the activity does not occur at the site, then there is no need to proceed with the assessment of that activity.

Vol 2 Table 4.5.3 Air quality – construction dust emission classes

Emission class	Activities
	Demolition
Large	Total building volume > 50,000m^3, potentially dusty construction material (eg, concrete), on-site crushing and screening, demolition activities >20m above ground level.
Medium	Total building volume 20,000m^3 – 50,000m^3, potentially dusty construction material, demolition activities 10m - 20m above ground level.
Small	Total building volume <20,000m^3, construction material with low potential for dust release (eg, metal cladding, timber), demolition activities <10m above ground level, demolition during wetter months.
	Earthworks
Large	Total site area >10,000m^2, potentially dusty soil type, >10 heavy earth moving vehicles active at any one time, formation of bunds >8m in height, total material moved >100,000 tonnes.
Medium	Total site area 2,500m^2 - 10,000m^2, moderately dusty soil type, 5 - 10 heavy earth moving vehicles active at any one time, formation of bunds 4m - 8m in height, total material moved 20,000 - 100,000 tonnes.
Small	Total site area <2,500m^2, soil type with large grain size, <5 heavy earth moving vehicles active at any one time, formation of bunds <4m in height, total material moved <10,000 tonnes, earthworks during wetter months.
	Construction
Large	Total building volume >100,000m^3, piling, on-site concrete batching, sandblasting.
Medium	Total building volume 25,000m^3 - 100,000m^3, potentially dusty construction material, piling, on-site concrete batching.
Small	Total building volume <25,000m^3, construction material with

Emission class	Activities
	low potential for dust release.
	Trackout
Large	>100 HGV trips in any one day, potentially dusty surface material, unpaved road length >100m.
Medium	25-100 HGV trips in any one day, moderately dusty surface material, unpaved road length 50m - 100m.
Small	<25 HGV trips in any one day, surface material with low potential for dust release, unpaved road length <50m.

Construction related volatile contaminant emissions

4.5.88 The assessment of the local air quality effects of naphthalene at Earl Pumping Station uses the percentage effects outlined in the EPUK guidance for NO_2, PM_{10}, NO_X and nitrogen deposition.

4.5.89 The magnitude of change has been identified using the criteria shown in Vol 2 Table 4.5.4.

Vol 2 Table 4.5.4 Air quality – contaminated land assessment magnitude of change

Magnitude of change	Annual mean naphthalene
Large	Increase / decrease > 1µg/m^3
Medium	Increase / decrease 0.5 – 1µg/m^3
Small	Increase / decrease 0.0025 - 0.0125ng/m^3
Negligible	Increase / decrease < 0.1µg/m^3

4.5.90 For the odour assessment of naphthalene, the EA benchmark for odour is the 98th percentile of hourly values is used. Impact magnitude criteria are given in Vol 2 Table 4.5.5 based on professional judgement using the detection threshold and benchmarks set by the EA for various levels of offensiveness of odour.

Vol 2 Table 4.5.5 Odour – impact magnitude criteria

Impact magnitude	Definition
High	98th percentile of hourly concentrations in a year >3ou$_E$/m^3
Medium	98th percentile of hourly concentrations in a year 1.5-3ou$_E$/m^3
Low	98th percentile of hourly concentrations in a year 1-1.5ou$_E$/m^3
Negligible	98th percentile of hourly concentrations in a year <1ou$_E$/m^3

Determining significance of effects

Local air quality

4.5.91 For local air quality the magnitude of change, as determined in Vol 2 Table 4.5.1, can be compared to the absolute concentration in relation to the relevant air quality criteria (for annual mean NO_2, hourly mean NO_2, annual mean PM_{10} and daily mean PM_{10}) to describe predicted air quality effects as detailed in Vol 2 Table 4.5.6 this determines the significance of effects. This table comes from the EPUK guidance and relates to those receptors of high sensitivity. Within Vol 2 Table 4.5.6, moderate and major adverse / beneficial effects represent a significant effect.

4.5.92 Vol 2 Table 4.5.6 has been used in conjunction with the following factors when judging overall significance:

a. number of properties affected by minor, moderate or major air quality impacts and a judgement on the overall balance

b. where new exposure is being introduced into an existing area of poor air quality, then the number of people exposed to levels above the objective or limit value is relevant

c. the magnitude of the changes and the descriptions of the impacts at the receptors

d. whether or not an exceedance of an objective or limit value is predicted to arise in the assessment area where none existed before or an exceedance area is substantially increased

e. whether or not the assessment area exceeds an objective or limit value and this exceedance is removed or the exceedance area is reduced

f. uncertainty, including the extent to which reasonable worst case assumptions have been made

g. the extent to which an objective or limit value is exceeded, eg, an annual mean NO_2 of 41µg/m^3 should attract less significance than an annual mean of 51µg/m^3.

Vol 2 Table 4.5.6 Air quality – significance of effect criteria

Magnitude of change	Absolute concentration in relation to standard			
	Above objective/limit value with scheme (>40µg/m^3)	Just below objective/limit value with scheme (36-40µg/m^3)	Below objective/limit value with scheme (30-36µg/m^3)	Well below objective/limit value with scheme (<30µg/m^3)
Large	Major adverse / beneficial	Moderate adverse / beneficial	Minor adverse / beneficial	Minor adverse / beneficial
Medium	Moderate adverse / beneficial	Moderate adverse / beneficial	Minor adverse / beneficial	Negligible

Magnitude	Absolute concentration in relation to standard			
Small	Minor adverse / beneficial	Minor adverse / beneficial	Negligible	Negligible

4.5.93 For the ecosystems assessment, the magnitude of change, as determined in Vol 2 Table 4.5.2, can also be compared to the absolute concentration / deposition in relation to the relevant air quality criteria or critical load. Process contribution can be considered significant if the long-term process contribution is more than 1% of the long-term environmental standard, ie, more than 0.3µg/m^3 for the NO_X concentration.

4.5.94 The threshold for the critical load depends on the relevant critical load for Barn Elms SSSI. An increase can again be considered significant if the long-term process contribution is more than 1% of this critical load.

Construction dust

4.5.95 The significance of construction dust effects have been determined by combining the identified impact magnitudes, with the receptors (and their sensitivity) affected by those impacts.

4.5.96 The significance of effects is dependent on the risk category of each activity and the sensitivity of the area surrounding the site.

4.5.97 Firstly the risk categories have been determined which uses the dust emission class identified for each activity (see Vol 2 Table 4.5.3) and considers this in the context of the distance to the closest receptors to identify the risk category for each activity at a given site. The risk categories are determined using the criteria in Vol 2 Table 4.5.7 to Vol 2 Table 4.5.9.

Vol 2 Table 4.5.7 Air quality – construction dust risk category, demolition

Distance to the nearest receptor (m)		Dust emission class		
Dust soiling and PM_{10}	**Ecological**	**Large**	**Medium**	**Small**
<20	-	High risk	High risk	Medium risk
20-100	<20	High risk	Medium risk	Low risk
100-200	20-40	Medium risk	Low risk	Low risk
200-350	40-100	Medium risk	Low risk	Negligible

Vol 2 Table 4.5.8 Air quality – construction dust risk category, earthworks and construction

Distance to the nearest receptor (m)		Dust emission class		
Dust soiling and PM_{10}	**Ecological**	**Large**	**Medium**	**Small**
<20	-	High risk	High risk	Medium risk
20-50	-	High risk	Medium risk	Low risk

Distance to the nearest receptor (m)		Dust emission class		
Dust soiling and PM_{10}	Ecological	Large	Medium	Small
50-100	<20	Medium risk	Medium risk	Low risk
100-200	20-40	Medium risk	Low risk	Negligible
200-350	40-100	Low risk	Low risk	Negligible

Note: including earthworks

Vol 2 Table 4.5.9 Air quality – construction dust risk category, trackout

Distance to the nearest receptor (m)		Dust emission class		
Dust soiling and PM_{10}	Ecological	Large	Medium	Small
<20	-	High risk	Medium risk	Medium risk
20-50	<20	Medium risk	Medium risk	Low risk
50-100	20-100	Low risk	Low risk	Negligible

4.5.98 The assessment of the risk categories for each of the four activities determines the mitigation measures required for the site. These mitigation measures have been taken from the GLA guidance, which covers the measures required for high, medium and low risk sites. These measures have been incorporated into the *CoCP* Part A Section 7.

4.5.99 The sensitivity of the surrounding area is defined in Vol 2 Table 4.5.10 below. The sensitivity of the receptors to construction dust identified using Vol 2 Table 4.4.2 is accounted for when determining the overall sensitivity of the area surrounding the site.

Vol 2 Table 4.5.10 Air quality – construction dust sensitivity criteria

Sensitivity of surrounding area	Examples	
	Human receptors	Ecological receptors
Very high	Very densely populated area More than 100 dwellings within 20m Local PM_{10} concentrations exceed the objective Contaminated buildings present Very sensitive receptors (eg, oncology units) Works continuing in one area of the site for more than one year	European designated site
High	Densely populated area 10-100 dwellings within 20m of site Local PM_{10} concentrations close to the objective	Nationally designated site

Sensitivity of surrounding area	Examples	
	Human receptors	Ecological receptors
	Commercially sensitive horticultural land within 20m	
Medium	Suburban or edge of town area Less than 10 receptors within 20m Local PM_{10} concentrations below the objective	Locally designated site
Low	Suburban or edge of town area Less than 10 receptors within 20m Local PM_{10} concentrations below the objective	No designations

4.5.100 Vol 2 Table 4.5.11 and Vol 2 Table 4.5.12 then define the significance of effects for each of the four activities (demolition, earthworks, construction and trackout) both without and with mitigation.

Vol 2 Table 4.5.11 Air quality – dust significance of effect criteria (no mitigation)

Risk of site giving rise to dust effects	Sensitivity of surrounding area			
	Very high	High	Medium	Low
High risk site	Major adverse	Moderate adverse	Moderate adverse	Minor adverse
Medium risk site	Moderate adverse	Moderate adverse	Minor adverse	Negligible
Low risk site	Moderate adverse	Minor adverse	Negligible	Negligible

Note: for each activity

Vol 2 Table 4.5.12 Air quality – dust significance of effect criteria (with mitigation)

Risk of site giving rise to dust effects	Sensitivity of surrounding area			
	Very high	High	Medium	Low
High risk site	Minor adverse	Minor adverse	Negligible	Negligible
Medium risk site	Minor adverse	Negligible	Negligible	Negligible
Low risk site	Negligible	Negligible	Negligible	Negligible

Note: for each activity

4.5.101 As the effects are transient, temporary and likely to be noticeable only in dry weather, a significant effect applies to moderate and major adverse effects.

Construction related volatile contaminant emissions

4.5.102 For the assessment of naphthalene, the magnitude of change, as determined in Vol 2 Table 4.5.4, can be compared to the absolute concentration in relation to the relevant air quality criteria to describe the significance of effects as shown in Vol 2 Table 4.5.13.

Vol 2 Table 4.5.13 Air quality – construction related volatile contaminant emissions significance of effect criteria

Magnitude of change	Absolute concentration in relation to standard			
	Above objective/limit value with scheme (naphthalene >10µg/m^3)	Just below objective/limit value with scheme (naphthalene 0.9-1µg/m^3)	Below objective/limit value with scheme (naphthalene 0.75-0.9µg/m^3)	Well below objective/limit value with scheme naphthalene <0.75µg/m^3)
Large	Major adverse / beneficial	Moderate adverse / beneficial	Minor adverse / beneficial	Minor adverse / beneficial
Medium	Moderate adverse / beneficial	Moderate adverse / beneficial	Minor adverse / beneficial	Negligible
Small	Minor adverse / beneficial	Minor adverse / beneficial	Negligible	Negligible

4.5.103 The significance of the odour effects of naphthalene has been assessed on the basis on professional judgement and has been derived from the impact magnitude shown in Vol 2 Table 4.5.5 and the sensitivity of receptors shown in Vol 2 Table 4.4.3. The significance criteria are shown in Vol 2 Table 4.5.14.

Vol 2 Table 4.5.14 Odour – significance of effect criteria

Significance		Receptor sensitivity		
		High	Medium	Low
Impact magnitude	High	Major adverse	Major adverse	Minor adverse
	Medium	Major adverse	Moderate adverse	Minor adverse
	Low	Minor adverse	Minor adverse	Negligible
	Negligible	Negligible	Negligible	Negligible

4.5.104 For the assessment of contaminated land, moderate and major adverse effects represent significant effects for both health and odour.

4.6 Operational effects assessment

4.6.1 This section describes the methodology for the assessment of odour during operation identifying the assessment years, assessment areas, modelling undertaken (including model inputs and outputs) and significance criteria used.

Assessment years

Odour

4.6.2 Dispersion modelling is undertaken for a typical use year representing typical rainfall levels. This 'Typical Year' has been derived from an analysis of measured rainfall in London over a 34 year period carried out by the Water Research Council (WRC, 2006)[35]. This identified the period of October 1979 – September 1980 as the best representation of a 'typical' year (hereafter Typical Year). A wet year was also identified in the rainfall analysis which was October 2000 – September 2001. This has been taken as the best representation of a Frequent Use Year. A qualitative comment has been made in Vols 4-27 as to how the impact in the Frequent Use Year would differ from that in the Typical Year.

4.6.3 As a Typical Year (rather than a specific year) has been assessed, a programme delay of approximately one year would not affect the odour assessment findings. No further consideration of this is therefore necessary.

Assessment areas

Odour

4.6.4 For odour, the assessment areas are site-specific (defined in Vol 4 to 27), being large enough to cover the area that could be affected by emissions from the ventilation structures. This area typically extends approximately 500m radius from the ventilation structures.

Methodology

Odour

4.6.5 The US EPA AERMOD atmospheric dispersion model (version 12060) has been used to predict concentrations across the assessment area. AERMOD is a steady-state atmospheric dispersion model that incorporates air dispersion based on modern atmospheric physics, including treatment of both surface and elevated sources, and both simple and complex terrain. The model calculates downwind concentrations in the surrounding area for each hour in the hourly sequential meteorological dataset. Statistics on the frequency and concentration at the receptors are based upon these hourly calculations. This model is used to support regulatory and non-regulatory requirements worldwide and is widely used in the UK for odour modelling.

4.6.6 Odour concentrations have been predicted for 98th percentile of hourly values in a year for comparison with the EA odour benchmark and the number of hours with odour concentrations above 1.5ou_E/m^3 has also been calculated.

4.6.7 When a plume flows over nearby buildings or other structures, turbulent eddies are formed in the downwind side of the building. Those eddies cause a plume from a stack source located within about five times the height of a nearby building or structure to be forced down to the ground much sooner than it would if a building or structure were not present. The effect can greatly increase the resulting nearby ground-level pollutant concentrations downstream of the building or structure. This phenomenon is known as building downwash and was taken into account in the modelling by using the Building Profile Input Program Prime (BPIP Prime). As many of the sites are near tall buildings, this is an important effect in central London.

Model inputs

4.6.8 The model uses source emission characteristics, meteorological data, terrain data and building information to predict odour concentrations.

Emission rates

4.6.9 Hydraulic modelling of inflow and depth in the main tunnel at each main tunnel shaft has been carried out using the InfoWorks software. The results from this modelling were used in the air movement model to estimate air release rates and H_2S concentrations at each main tunnel site. H_2S concentrations in sewers are very variable as the actual concentration depends upon a variety of factors. Odour concentrations in the tunnel air were estimated from the H_2S concentrations using a correlation between the two based on odour and H_2S measurements made in sewers at a range of London sites.

4.6.10 As the project sites are mainly in built up areas of London, there is usually relevant exposure (public access) in all areas surrounding the ventilation column(s). The *NPS* refers to the standard needing to be considered in open areas, so the maximum concentration that could occur anywhere at ground level has been reported. This identifies the worst case impact allowing ventilation column(s) to be moved within the parameters for each site without impacts being worse than those reported. This approach has been followed for sites that have low emissions (ie, those with passive ventilation) and do not have large buildings within 10m of the site boundary that could affect dispersion.

4.6.11 For the project sites that have the potential to have a greater impact at height, ie, those with active ventilation, modelling has been carried out at the worst case location, within the parameter plans for each site, for the ventilation column(s). The highest concentrations at these sites are likely to occur at buildings at height which are reported.

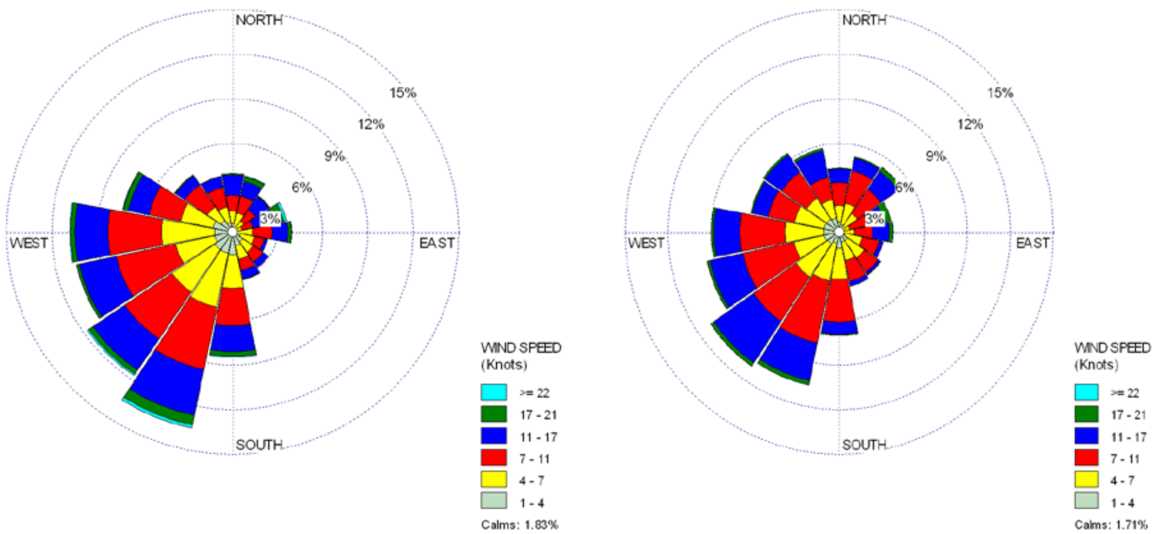
Meteorological data

4.6.12 A meteorological dataset has been compiled specifically for use in the AERMOD model using data from London Heathrow. Meteorology is affected by ground surface conditions so the surrounding land is characterised in terms of surface roughness, Bowen ratio and albedo for each season. The surface roughness length used was 1m. The meteorological file for use in AERMOD was prepared using the processor AERMET. The urban option was selected in AERMOD to take account of the extra heat in the city compared with rural areas that can affect the stability of the atmosphere.

4.6.13 As the emission and flow rates for the Typical Year relate to an actual year, the corresponding meteorological dataset for that year has been used in the modelling which was 1979-80. The corresponding meteorological dataset has been used as it gives a better indication of concentrations rather than using a recent year of data where the meteorological data may not be consistent with a rainfall event leading to the tunnel emissions. Hours with missing meteorological data in the dataset have been infilled, based on the meteorological conditions in the adjacent hours, to avoid a missing hour of meteorology coinciding with an hour of high emissions.

4.6.14 Wind roses for the Typical Year assessment (1979-1980 – as determined by the analysis of 34 years of measured rainfall data in London as explained in para. 4.6.2) are shown in Vol 2 Plate 4.6.1. Both wind roses clearly show a predominant southwesterly wind, with winds originating in this quadrant for 30-35% of the time. Light winds (up to 2m/s) occurred for 13-14% of the time in both years. The dominant wind direction with light winds was southerly. It is generally considered that light winds and calm conditions result in the greatest odour impact.

Vol 2 Plate 4.6.1 Odour – wind roses for Heathrow 1979 and 1980



Terrain data

4.6.15 The ventilation sites are located near the River Thames and are generally on low level flat ground. In order to allow for any local topography that could affect air movements, digital terrain mapping (DTM) with a resolution of 5m was used in the modelling. This was processed in the US EPA terrain pre-processor AERMAP to produce data in a suitable format for use in AERMOD. This file contained elevation and hill height scaling factors for each receptor in AERMOD.

Building information

4.6.16 Building height data were provided by Thames Water from the Digital Surface Model. Any buildings that could affect dispersion of the tunnel air plumes were entered into the model.

Background concentrations

4.6.17 The project ventilation main tunnel shafts at Beckton would be located at the sewage treatment works. All sources within the sewage treatment works have been modelled so that total odour concentrations can be assessed. At the other sites, no allowance has been made for the odour contribution from other sources.

4.6.18 For environmental impact assessment (EIA) of new developments, a background odour concentration of zero is generally used. This is because of the difficulties of measuring background or existing odour continuously throughout the year to quantitatively determine background levels. Odour can be caused by a wide range of substances with no instrument being capable of detecting every odorant at once and measuring it continuously. Spot sampling of hydrogen sulphide as an indicator of odour has been carried out but this is not suitable to use to determine background odour concentrations.

4.6.19 At the majority of sites, there are no significant sources of sewage odour in the surroundings and no complaints have been made indicating that background odour levels are likely to be low. At some of the sites, odour complaints have been made indicating that background odour concentrations have been raised on some occasions. With the Thames Tideway Tunnel project, it is expected that background odour levels would decrease at some sites and remain the same at others. The sites are discussed individually in Vol 4 to 27. The total odour concentration at some of the sites could be higher than that modelled for sites where there are other odour sources in the area such as restaurants but this is unlikely to affect the significance of the results.

Model outputs

4.6.20 Concentrations have been predicted at 5m intervals across the assessment area for each site in a Cartesian grid at a height of 1.5m to represent human exposure. Maximum concentrations at ground level beyond the site boundary are reported. In addition, modelling has been carried out at the same height as the release height to assess concentrations at height at buildings close to the ventilation columns where concentrations could be higher than at ground level and people could be exposed. These maximum concentrations could either be at ground level or at height. Concentrations at selected receptors have also been predicted and assessed for significance.

Model verification

4.6.21 The AERMOD dispersion model has been extensively verified as part of its development so the dispersion algorithms within the model perform well. In principle, model verification should also be carried out for each modelling study using emission factors, topography and sources similar to those in the study. For odour modelling of proposed sources, model verification is not carried out as there is no monitoring data from a similar environment that can be used for the verification.

Significance criteria

Determining magnitude of impacts

4.6.22 As the EA benchmark for odour is the 98th percentile of hourly values, the magnitude of impact should also be assessed using this metric. Impact magnitude criteria are given in Vol 2 Table 4.6.1 based on professional judgement using the detection threshold and benchmarks set by the EA for various levels of offensiveness of odour.

Vol 2 Table 4.6.1 Odour – impact magnitude criteria

Impact magnitude	Definition
High	98th percentile of hourly concentrations in a year >3ou_E/m^3
Medium	98th percentile of hourly concentrations in a year 1.5-3ou_E/m^3
Low	98th percentile of hourly concentrations in a year 1-1.5ou_E/m^3
Negligible	98th percentile of hourly concentrations in a year <1ou_E/m^3

Determining significance of effects

4.6.23 The significance criteria are based on professional judgement and have been derived from the impact magnitude shown in Vol 2 Table 4.6.1 and the sensitivity of receptors shown in Vol 2 Table 4.4.3. The significance criteria are shown in Vol 2 Table 4.6.2 with moderate and major adverse effects identified as being significant effects.

Vol 2 Table 4.6.2 Odour – significance of effect criteria

Significance		Receptor sensitivity		
		High	Medium	Low
Impact magnitude	High	Major adverse	Major adverse	Minor adverse
	Medium	Major adverse	Moderate adverse	Minor adverse
	Low	Minor adverse	Minor adverse	Negligible
	Negligible	Negligible	Negligible	Negligible

4.7 Cumulative effects assessment

4.7.1 The general approach to assessing cumulative effects is described in Section 3. The specific approach for air quality and odour is described below. The assessment years considered for the cumulative effects assessment remain as described in Sections 4.5 and 4.6 above.

Construction

4.7.2 Other committed developments in the vicinity of each site likely to be complete and operational or under construction during the peak construction year at each site have been included in the traffic data used in the modelling in order that cumulative effects of likely developments have been inherently included in the air quality assessment. The future developments have been identified as those developments in the site development schedules (Appendix A.2 of Volume 3 and Appendix N of Vol 4 to 27), which are within the local air quality assessment areas. Allowance has also been made for construction dust from other developments under construction within 350m of Thames Tideway Tunnel project sites. Professional judgement has been used to determine whether the sensitivity of the surrounding area should be increased to reflect the potential for cumulative effects.

Operation

4.7.3 Other committed developments in the vicinity of each site likely to be complete and operational for operational years have been included in the modelling if they are likely to affect dispersion from the vent. The committed developments have been identified in the site development schedules (Appendix A.2 of Volume 3 and Appendix N of Vol 4 to 27) and have been included if they were within a distance of five times the lesser of the building height or width from the vent.

4.8 Project-wide effects assessment

4.8.1 The general approach to assessing the likely significant effects, including project-wide effects, is described in Section 3. The specific approach for assessing project-wide air quality effects is described below.

4.8.2 As described in Volume 3 Project-wide effects assessment, no project-wide effects are considered likely for odour. Operational project-wide effects have therefore not been assessed in the EIA.

Construction

4.8.3 Construction works at the project sites would lead to project-wide interactions of construction traffic along major road corridors which could have air quality impacts.

Assessment years

4.8.4 The assessment year for the project-wide effects assessment is the year in which the peak annual construction traffic for the construction traffic routes occurs. For the identified peak year, a base case has been assessed including all appropriate emission sources without the Thames Tideway Tunnel project.

4.8.5 The development case has then been assessed in the same peak construction year, but including the Thames Tideway Tunnel project. The assessment considers the ‘development case’ compared with the ‘base case’ in a particular assessment year.

Assessment areas

4.8.6 The assessments areas for the project-wide assessment is governed by the road corridors which have significant number of construction lorries being generated by the Thames Tideway Tunnel project. The threshold used for the project-wide assessment is taken from the DMRB assessment methodology. This methodology states that a significant impact is an increase of 200 HGVs per day measured as an Annual Average Daily Traffic (AADT) flow. The only road corridor that exceeds this threshold is the A2 corridor from Greenwich to the Kent disposal site. Therefore, sensitive receptors along this road corridor have been assessed in the project-wide assessment.

Methodology

4.8.7 The project-wide assessment has used the same methodology as the local air quality methodology for the sites during construction (see Section 4.5). The modelling has included the effects from road traffic along the A2 corridor. Receptors along the A2 corridor have been selected based on their proximity to the roadside.

Significance criteria

Determining magnitude of impacts

4.8.8 The methodology for determining the magnitude of impacts is the same as described in para. 4.5.83.

Determining significance of effects

4.8.9 The methodology for determining the significance of effects is the same as described in para. 4.5.90 – 4.5.91.

Project-wide cumulative effects

Construction

4.8.10 As described in Vol 3 (Section 4.3), cumulative effects are inherently considered in the assessment.

4.9 Assumptions and limitations

4.9.1 This section details general assumptions and limitations associated with the air quality and odour assessment. Site-specific assumptions and limitations are detailed in Vol 4 to 27 Section 4 Air quality and odour.

Assumptions

Construction – local air quality

4.9.2 The modelling for future years are dependent on forecasts of:

a. traffic data

b. vehicle fleet compositions

c. the maintenance of older vehicles

d. the performance of the UK economy

e. the predictions of the models

f. the predictions of background concentrations.

4.9.3 Vehicle emission factors and fleet composition data have been based on those provided by Defra.

4.9.4 Tug (for river barges) emission factors have been taken from EMEP Corinair Pollutant Emissions Inventory Guidebook.

4.9.5 Plant emission factors have been taken from EMEP/EEA Guidebook. In order to take into account the change of emissions with the age, degradation factors as shown in Guide Book for diesel machinery have been applied where relevant.

Operation – odour

4.9.6 The modelling for future years is dependent upon:

a. the assumptions made about the size of adjacent buildings

b. rainfall forecasts

c. weather forecasts

d. odour emission rate forecasts

e. the predictions of the models.

4.9.7 A range of assumptions have been made regarding the odour emission rates including:

a. A minimum odour strength in releases from the ventilation columns has been assumed which is likely to have led to an overestimate of concentrations.

b. It is assumed that the odour is highly offensive, even when some of the air would be treated in the carbon filter and would be less offensive

c. The relationship between odour and H_2S concentrations in the releases was estimated based on measurements made at combined sewer overflow (CSO) sites. The correlation between odour and H_2S concentrations showed variation between samples leading to uncertainty in the odour emissions but overall is likely to provide a realistic estimate.

4.9.8 For the project sites that have the potential to have a greater impact at height (ie, those with active ventilation), modelling has been carried out at the worst case location for the ventilation column(s) (based on professional judgement), within the parameter plans for each site.

Limitations

Construction – local air quality

4.9.9 At some monitoring sites, data capture has been less than 90% due to diffusion tubes being lost / vandalised (see para. 4.4.13). Where this is the case, following bias adjustment using the co-located diffusion tubes, these results have been seasonally adjusted.

Operation – odour

4.9.10 No information was available on future background odour concentrations due to emissions from other sources so these were not included in the modelling. Also, verification of the model results could not be carried out as no data was available to use. The assessment has however been carried out using the latest technical knowledge so is robust.

4.10 Mitigation

Construction

4.10.1 The Thames Tideway Tunnel project has been designed to minimise environmental effects and therefore the construction design/methods take account of air quality considerations including measures within the Section 7 of *CoCP* Part A and B. Where such measures form part of the project, they are identified in Volume 1 Introduction to the Environmental Statement (for the tunnel itself) and Section 3 of Vol 4 to 27 (for each site) and have been considered as embedded measures within the assessment.

4.10.2 Where the assessment indicates significant effects having taken account of embedded measures, mitigation has been identified where possible.

Operation

4.10.3 The Thames Tideway Tunnel project has been designed to minimise environmental effects and therefore the design takes account of odour considerations including odour management input to the ventilation system design. Where such measures form part of the project, they are identified in Vol 1 (for the tunnel itself) and Section 3 of Vol 4 to 27 (for each site) and have been considered as embedded measures within the assessment.

4.10.4 Where the assessment indicates significant effects having taken account of embedded environmental design, mitigation has been identified as appropriate.

4.11 Residual effects assessment

4.11.1 Where mitigation measures are proposed, residual effects as assessed using the appropriate methodologies previously outlined in Section 4.5 and Section 4.6.

4.11.2 Where no mitigation measures are proposed, the residual effects remain as identified through the relevant assessment (construction, operation or project-wide).

This page is intentionally blank

References

[1] Thames Water. *Thames Tideway Tunnel Scoping Report, Environmental impact assessment* (March 2011).

[2] Defra. *The Air Quality Strategy for England, Scotland, Wales and Northern Ireland Vol 1* (2007).

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

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

[5] Office of the Deputy Prime Minister. *Minerals Policy Statement 2, Controlling and Mitigating the Environmental Effects of Mineral Extraction in England: Annex 1 Dust* (2005).

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

[7] Building Research Establishment. *Control of Dust from Construction and Demolition Activities* (2003).

[8] CIRIA. *Environmental Good Practice on Site* (2010).

[9] Environmental Protection UK. *Development Control: Planning For Air Quality* (2010).

[10] Defra, *National Policy Statement for Waste Water* (March 2012).

[11] Defra, *Odour Guidance for Local Authorities* (March 2010)

[12] Environment Agency, *H4 Odour Management, how to comply with your environmental permit* (March 2011)

[13] Defra, *Odour Guidance*. See citation above.

[14] Institute of Air Quality Management. See citation above.

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

[16] Highways Agency. See citation above.

[17] Environment Agency. See citation above.

[18] Defra, *Odour Guidance for Local Authorities* (March 2010)

[19] Environment Agency. See citation above.

[20] AEA Technology. *UK Informative Inventory Report (1980 to 2010)* (2012).

[21] Greater London Authority. *Clearing the air, The Mayor's Air Quality Strategy* (2010).

[22] Institute of Air Quality Management. *Guidance on Air Quality Monitoring in the Vicinity of Demolition and Construction Sites*, In Draft (March 2012).

[23] London Air Quality Network. Available at: http://www.londonair.org.uk/LondonAir/Default.aspx. Last accessed June 2012.

[24] Defra. 2010 Based Background Maps. Available at http://laqm.defra.gov.uk/maps/maps2010.html. Accessed October 2012.

[25] Defra. Emissions Factor Toolkit, Version 5.1. Available at http://laqm.defra.gov.uk/review-and-assessment/tools/emissions.html#eft. Accessed October 2012.

[26] Air Pollution Information System. Available at: http://www.apis.ac.uk. Accessed June 2012.

[27] Air Quality Expert Group. *Nitrogen Dioxide in the United Kingdom* (2004).

[28] Air Quality Consultants. *Deriving NO_2 from NO_X for Air Quality Assessments of Roads* (2006).

[29] Defra. *NO_X to NO_2 Calculator version 3.2*. http://laqm.defra.gov.uk/tools-monitoring-data/no-calculator.html. Accessed October 2012.

[30] Grice, S., Stedman, J., Kent, A., Hobson, M., Norris, J., Abbott, J., Cooke, S. *Recent Trends and Projections of Primary NO_2 Emissions in Europe*, Atmospheric Environment 43, 2154-2167 (2009).

[31] EMEP. *Corinair Pollutant Emissions Inventory Guidebook 2009. Part B: Sectoral Guidance Chapters. Chapter 1.A.3.d: Navigation* (Updated March 2011).

[32] BSI British Standards. *BS 5228-1-2009, Code of Practice for Noise and Vibration Control on Construction and Open Sites* (2009).

[33] Environmental Protection UK. See citation above.

[34] Environment Agency. *H1 Guidance, Annex F.* Available at: http://publications.environment-agency.gov.uk/PDF/GEHO0410BSIL-E-E.pdf. Accessed June 2012.

[35] Water Research Council. *Thames Tideway Study: Selection of typical year for CSO spill frequency assessment*, personal communication (31st August 2006).

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.02**

Volume 2: Environmental assessment methodology

Section 5: Ecology - aquatic

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

Hard copy available in

Box **16** Folder **A**
January 2013

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

This page is intentionally blank

Thames Tideway Tunnel

Environmental Statement

Volume 2: Environmental assessment methodology

Section 5: Ecology – aquatic

List of contents

Page number

List of plates

Page number

List of tables

Page number

5 Ecology – aquatic

5.1 Introduction

5.1.1 This section sets out the methodology for assessing the likely significant effects of the Thames Tideway Tunnel project on aquatic ecology. It builds upon the general assessment methodology summarised in Section 3 of this volume and develops this to take account of the range of likely significant environmental effects on aquatic ecology arising from the construction and operation of the project.

5.1.2 The methodology outlined in this section has been applied to all sites, unless otherwise indicated in the site assessment volumes. The methodology for assessing project-wide effects is also described.

5.1.3 The need for an assessment of aquatic ecology effects results from the potential for the project to affect the following aquatic ecology receptors which occur within the tidal reaches of the River Thames (tidal Thames) and its tidal tributaries:

a. designations and river dependent habitats

b. mammals

c. fish

d. benthic and pelagic invertebrates

e. algae.

5.1.4 The aquatic ecology assessment considers effects within the subtidal and intertidal zone of the river. Habitats and species outside these zones, including birds and specifically waterfowl have been considered under the terrestrial ecology topic in this volume (Section 6).

5.1.5 The water quality improvements that would arise from the interception of the combined sewer overflows (CSOs) have been assessed under the surface water resources topic (Section 14). Information from this assessment and from predictive water quality modelling has been used to inform the assessment of effects on aquatic ecology receptors during the operational stage of the project.

5.2 Engagement

5.2.1 The general approach adopted regarding engagement is summarised in Section 2 of this volume. The approach to stakeholder engagement for aquatic ecology, and the key issues arising from the consultation process are summarised below.

5.2.2 Engagement with stakeholders included a regular Thames Tideway Tunnel biodiversity working group meeting which was attended by the Environment Agency (EA), Natural England and local authority borough ecologists. Meetings were held approximately every 4-6 months and consisted of interactive workshop sessions. Discussions with stakeholders included the proposed approach and methodologies for surveys, the approach and scope of proposed modelling to predict the effects of the foreshore sites during construction and operation on fish populations and the approach to compensation and mitigation.

5.2.3 A position paper (see Vol 2 Appendix C.1) setting out the intended methodology for undertaking the aquatic ecology assessment was circulated in January 2011 to local planning authorities, the EA, Natural England and the London Biodiversity Partnership. Responses identified that effects on the foreshore would require detailed assessment, including scour effects due to changes in flow rate or regime and effects on river walls as habitat. They also stated that judgments concerning the magnitude of impacts and assessment of effects would require justification, informed by literature sources where appropriate. They emphasised that the focus should be on minimising foreshore impacts wherever possible and building ecological enhancements into permanent features.

5.2.4 A detailed response to the *Scoping Report* consultation was received from the EA. In summary, the key points were that:

a. construction areas and permanent landtake in the river should be minimised as much as possible

b. new structures may provide an opportunity to create new intertidal habitat features

c. fish passage improvements should be considered where modelling indicates they would be useful.

5.2.5 The Infrastructure Planning Commission provided general comments on the scope of the aquatic ecology assessment and the types of effects to be assessed, including that noise and vibration impacts should be considered and that dewatering impacts on the river should also be taken into account (see Vol 2 Appendix A.3). The City of London Corporation noted that foreshore erosion should be included within assessments. The London Borough (LB) of Wandsworth specifically requested that consideration be given to the issue of invasive species.

5.2.6 In response to phase two consultation the EA noted the reduction in the number of foreshore sites with permanent structures from eight to seven. They also acknowledged the use of the mitigation hierarchy (avoid, mitigate, compensate, enhance) (Vol 2 Appendix C.3). The EA along with the Marine Management Organisation (MMO) requested that the impacts of any dredging activity required for the construction and operational phases should be included within the assessment. In addition to the water quality benefits the project should include proposals for ensuring long-term biodiversity gains along the whole route. The EA along with the MMO stated that ecological and other environmental impacts should be robustly mitigated for in line with existing legislation and guidance.

5.2.7 The EA also identified that the impact of campsheds and scour protection would need to be covered in the *Environmental Statement* and that impacts associated with the relocation of existing riverside features was also covered. Finally, the EA commented that the *Preliminary* *environmental information report* (*PEIR*) focussed heavily on the potential negative impacts of the project and that the *Environmental Statement* should have increased consideration of the ecological benefits.

5.2.8 All of these comments have been taken into account in developing the assessment methodology and the reporting of the assessment namely: undertaking juvenile fish surveys; modelling scour and changes to river hydrodynamics due to permanent structures; including consideration of algal communities, lighting impacts and invasive species; and ensuring where possible permanent structures are designed with ecologically beneficial features. The ecological benefits of the Thames Tideway Tunnel project resulting from improvements in water quality are presented in each site volume of the ES where a CSO is proposed for interception (Vols 4 to 27), and the overall ecological benefits are assessed in Vol 3 Project wide. Throughout the assessment process, there has been ongoing engagement with stakeholders on the development of the design, and mitigation measures, which have been incorporated into the proposals.

5.2.9 No comments were made in respect of the aquatic ecology EIA methodology in response to the Section 48 report.

5.2.10 In addition to the consultation identified above, the approach to juvenile fish modelling described in para. 5.8.22, and the behavioural rule sets used within it were agreed in advance with the EA.

5.3 Legislation and guidance

5.3.1 This section sets out the legislation and guidance that has informed the methodology for assessing aquatic ecology effects. Information on relevant European and domestic legislation is presented. This identifies the statutory protection of particular habitats and wildlife. Policy guidance is then described. Both of these have influenced the relative value that has been placed on habitats and species. The approach to assessment is based broadly on the *Institute of Ecology and Environmental Management (IEEM) Guidelines* (IEEM, 2006)[1]. Methodologies developed for previous London Tideway Improvement (LTI) projects (Thames Water Utilities Limited, 2008)[2,3] have also been drawn upon.

EU Habitats Directive (92/43/EEC) and Conservation of Habitats and Species Regulations

5.3.2 One of the aims of the Habitats Directive is to promote the maintenance of biodiversity by requiring Member States to take measures to maintain or restore natural habitats and wild species listed on the Annexes to the Directive at a favourable conservation status, as defined in Articles 1 and 2. The Habitats Directive is interpreted into English law through the Conservation of Habitats and Species Regulations 2010. Species protected under the Regulations/Directive include all species of dolphin, porpoise and whale, several of which have been recorded in the tidal Thames. The Conservation of Habitats and Species (Amendment) Regulations 2011 were added in order to provide greater clarity with regard to marine planning and the marine environment.

EU Water Framework Directive (2000/60/EEC)

5.3.3 The Water Framework Directive commits EU member states to achieve good qualitative and quantitative status of all water bodies (including marine waters up to one kilometre from shore) by 2015.

5.3.4 The Directive defines surface water status as the general expression of the status of a body of surface water. Status is divided into two components: ecological and chemical. Overall status for any given waterbody is determined by the poorer of the two components. Thus, to achieve good surface water status both the ecological status and the chemical status of a surface water body need to be at least good.

5.3.5 Ecological status refers to the quality of the structure and functioning of aquatic ecosystems of the surface waters. It is comprised of both biological and chemical components which are recorded on a scale of high, good, moderate, poor or bad, where high represents largely undisturbed conditions. The biological components include fish, macroinvertebrates (aquatic invertebrates), macrophytes (aquatic plants) and algae.

5.3.6 The Directive allows for the designation of Heavily Modified Water Bodies (HMWB). HMWB are bodies of water which, as a result of physical alternation by human activity, are substantially changed in character and cannot meet 'good' ecological status. The environmental objective for HMWB is 'good ecological potential' which has to be achieved by 2015. The tidal Thames is designated as an HMWB.

5.3.7 The key environmental objectives of the Directive are defined in Article 4 and include:

a. prevent deterioration of the status of all bodies of surface water

b. protect, enhance and restore all bodies of surface water, with the aim of achieving good surface water status by 2015

c. 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.

5.3.8 The Directive requires the production of a number of key documents over six year planning cycles. Most important among these is the *River Basin Management Plans*, the first published in 2009 with further plans to be published in 2015 and 2021 (EA, 2009)[4]. The Directive has been used in the aquatic ecology assessment to define the tidal Thames.

Wildlife and Countryside Act 1981 (as amended)

5.3.9 The Wildlife and Countryside Act 1981 (as amended in 1985, 1991, 2000 [by the Countryside and Rights of Way Act] and 2004) is the principal piece of legislation in the UK in terms of wildlife protection. It translates the Convention on the Conservation of European Wildlife and Natural Habitats (the Bern convention) into UK law. There are two main aspects, namely the designation of Sites of Special Scientific Interest (SSSI) and species protection.

5.3.10 Species protection applies to aquatic invertebrates (including tentacled lagoon worm) and marine mammals (all dolphins and porpoises) which have been recorded in the tidal Thames.

5.3.11 Most species covered by the Act (including those listed above) are protected from:

a. killing, injuring or taking

b. damage to, destruction of, obstruction of access to any structure or place used by a scheduled animal for shelter or protection

c. disturbance of animal occupying such a structure or place.

5.3.12 The Act also applies to some fish species, but does not include species found with regularity in the tidal Thames.

Natural Environment and Rural Communities Act (NERC) 2006

5.3.13 This Act requires all public bodies (including local authorities and utilities providers such as Thames Water) to have regard to biodiversity and tasks the Government to take positive steps to further the conservation of species and habitats listed in the Convention on Biological Diversity 1992.

5.3.14 Section 41 of the Act identifies key UK habitats and species. These form the *UK Biodiversity Action Plan* and were therefore used in assigning value to habitats and species within the aquatic ecology assessment. Section 40 of the Act identifies that local authorities must have regard to such habitats and species. Sites of Importance for Nature Conservation (SINC) are designated in line with Section 41 of the Act.

Marine and Coastal Access Act 2009

5.3.15 The Act creates a network of Marine Conservation Zones (MCZs) to protect some of the UK's most important marine species and habitats, overseen by a Marine Management Organisation. The tidal Thames (up to Teddington Weir) is part of the proposed Thames Estuary Marine Conservation Zone that was submitted to Government in early 2012 and. This includes the assessment area for this project. According to the Defra website[5] a decision on designation is expected in mid 2013, and thus before the decision is made on the Thames Tideway Tunnel application for a Development Consent Order (DCO). Independently of MCZ designations, the Marine Management Organisation determines licenses, including Marine Licences which replace licences issued under Part 2 of the Food and Environment Protection Act 1985.

5.3.16 Assuming the MCZ is designated, the decision-maker dealing with the application for a Development Consent Order (DCO) relating to the Thames Tideway Tunnel will need to comply with the duties imposed by section 126 of the MCA 2009. This imposes certain duties on public authorities determining applications for authorising the doing of an act, if the act is capable of affecting (other than insignificantly) the protected features of a MCZ, or any ecological or geomorphological process on which the conservation of any protected feature of a MCZ is (wholly or in part) dependent.

5.3.17 Independently of MCZ designations, the Marine Management Organisation determines licenses, including Marine Licences which replace licences issued under Part 2 of the Food and Environment Protection Act 1985.

Eels (England and Wales) Regulations 2009

5.3.18 The Regulations implement EC Council Regulation 1100/2007 which establishes measures for the recovery of European eel stocks. Eleven *Eel Management Plans* have been prepared relating to each of the river basin districts in England and Wales established under the Water Framework Directive. The assessment area for this project is included in the *Eel Management Plan* area for the South East river basin district[6]. The overall objective is to achieve a target of ensuring that 40% of adult eels are able to return to the sea to spawn.

Biodiversity Action Plans

5.3.19 There are a series of *Biodiversity Action Plans* (*BAPs*) that have informed the judgments regarding habitat/species importance:

a. The UK *BAP* is the UK Government's response to the Convention on Biological Diversity (1992). It describes the country's important biological resources and has resulted in the production of detailed plans for the protection of key habitats and species.

b. London *BAP*, which details priority species and habitats for conservation action in Greater London

c. London Borough local *BAPs* (*LBAPs*), where these have been produced, which detail priority species and habitats for conservation action within each London Borough

d. Thames Water published a four-part company *BAP* in 1999 to protect and enhance biodiversity on Thames Water sites and during their operations.

5.3.20 The methodology for assessing the effects on aquatic ecology has been informed by the legislation described above and also by the following:

a. Guidelines for Ecological Impact Assessment in the United Kingdom. IEEM (2006), commonly known as and referred to from here on as the IEEM Guidelines. Although these guidelines are currently under review, as this is ongoing the current guidelines are applied. The IEEM Guidelines have been applied to the assessment methodology with additional terminology used in the valuation (Vol 2 Table 5.4.4) and assessment of significant effects (Vol 2 Table 5.5.1) in line with the project-wide approach to the assessment as described in Section 3 General EIA methodology.

b. There is a hierarchy of designated sites within the UK, as follows:

i Special Areas for Conservation (SAC) – European statutory designated sites protected for habitats, plants and animals under the Conservation of Habitats and Species Regulations 2010 (The Habitats Regulations 2010).

ii Special Protection Areas (SPA) – European statutory designated sites for birds under The Conservation of Habitats and Species Regulations 2010.

iii Sites of Special Scientific Interest (SSSI) – National statutory designated sites protected under the Wildlife and Countryside Act 1981 and the Countryside and Rights of Way (CROW) Act 2000.

iv National Nature Reserves (NNRs) – a selection of the best SSSIs chosen by the statutory authority (Natural England) and often having other designations such as SAC or SPA.

v Local Nature Reserves (LNRs) – Statutory designated sites that are the best examples within a district or county. They are designated under Section 21 of the National Parks and Access to the Countryside Act 1949, and amended by Schedule 11 of the Natural Environment and Rural Communities Act 2006.

vi Sites of Importance for Nature Conservation (SINCs or Local Sites) – non-statutory designated sites implemented by the local authority and given material consideration in the planning process. Whilst these are called Local Sites, they range from local to county designated sites. In London, SINCs are subdivided into the following categories:

- SINC (Grade L), which is a site of local importance
- SINC (Grade B), which is a site of borough importance
- SINC (Grade M), which is a site of metropolitan importance.

5.3.21 The criteria on which these designations are based have been used to inform the valuation criteria for ecological receptors (see Section 5.4). For example, a site that is not currently designated as a nature conservation site is evaluated against the corresponding criteria for designated sites and valued accordingly. Similarly, the same criteria are applied to the evaluation of designated sites to confirm their current status.

5.3.22 A mitigation strategy has been developed to enable significant adverse effects of the project on aquatic ecology to be avoided, reduced, mitigated and/or compensated for, as described in Section 5.10. In developing this strategy, consideration has been given to the following policies, in addition to the legislation and guidance outlined above:

a. *Natural Environment White Paper 2011*, which sets out measures to protect and improve the health of ecosystems, the need to acknowledge that nature works as a system, which has a variety of functions and benefits (ecosystem services), and highlights the importance and values of coherent ecological networks and the need to take a landscape scale approach. Introduces the concept of 'biodiversity offsets' which are 'conservation activities designed to deliver biodiversity benefits in compensation for losses in a measurable way'. The purpose of biodiversity offsets is to ensure that developments result in no loss of biodiversity overall (HM Government, 2011)[7].

b. The National Planning Policy Framework states that *'the planning system should contribute to and enhance the natural and local environment by minimising impacts on biodiversity and providing net gains in biodiversity where possible, contributing to the Government's commitment to halt the overall decline in biodiversity, including by establishing coherent ecological networks that are more resilient to current and future pressures' (Department for Communities and Local Government, 2012*)[8]*.*

c. The Environment Agency's policy on encroachment on tidal rivers and estuaries states that the Agency is 'generally opposed to works on tidal rivers and estuaries that causes encroachment'. The policy also states that the Agency will welcome those aspects of development which lead to:

   i Opportunities to realign the flood defences landward and increase the storage volume of tidal rivers and estuaries

   ii Enhanced opportunities for fisheries and other ecology which make a contribution to the delivery of opportunities for enhancing the ecological integrity of tidal rivers and estuaries leading to the achievement of Biodiversity Action Plan targets

d. A range of local, regional and national planning policies are relevant to aquatic ecology. The majority of local policies seek the following as part of development proposals:

   i Measures to avoid, mitigate or compensate for effects on local non-statutory site designations and species of local interest.

   ii Protection measures for sensitive habitats.

e. The National Policy Statement for Waste Water. Vol 2 Table 5.3.1 presents the requirements within the NPS relevant to aquatic ecology and explains how the requirements have been addressed within the *Environmental Statement*. The table also gives the location of the relevant material.

Vol 2 Table 5.3.1 Aquatic ecology – requirements of the NPS and how they have been addressed

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
The applicant should ensure that the ES clearly sets out any effects on internationally, nationally and locally designated sites of ecological or geological conservation importance, on protected species and on habitats and other species identified as being of principal importance for the conservation of biodiversity.	The receptors scoped into the aquatic ecology assessment are those designated sites, habitats and species for which there is a potential for significant adverse or beneficial effects. They include marine mammals, fish, invertebrates and algae which depend on the tidal Thames. The designated sites and habitats scoped into the assessment are those which are either directly associated with the tidal Thames, or are hydrologically connected to it either through surface water or ground water linkages. The scope of the assessment was set out in the *Scoping Report*. The impacts of the project on aquatic ecology receptors are set out in the site specific and project wide assessments for both the construction and operational stage of the project. The predicted responses of the individual receptors to those impacts, termed effects, are also described. Where necessary, predictive tools such as numerical models and statistical analyses have been used to provide evidence to support the assessment.	The assessments of effects on ecological receptors are considered at both a site specific and project wide scale. Site specific assessments for each of the Thames Tideway Tunnel project sites are presented in Volumes 4 to 27. Project wide effects are presented in Volume 3.
The **applicant** should demonstrate that habitats will, where practicable, be restored after construction works have finished.	A mitigation strategy has been developed during the design stage of the project to avoid impacts wherever practicable. Where impacts are unavoidable, measures would be implemented to minimise the effect such as the careful reinstatement of intertidal	The mitigation strategy can be found in Vol 2 Section 5.10. The description of amendments made during the design process is provided in Vol 1.

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
	habitats affected by temporary landtake.	Measures to avoid and minimise impacts during construction can be found in Section 9 of the *Code of Construction Practice* (*CoCP*). This is provided in Vol 1 Appendix A. It contains general requirements (Part A), and site specific requirements for (Part B).
The **applicant** should show how the project has taken advantage of opportunities to conserve and enhance biodiversity and geological conservation interests. The **applicant** should demonstrate that opportunities will be taken to enhance existing habitats and, where practicable, to create new habitats of value within the site landscaping proposals. The **applicant** should demonstrate that during construction, they will seek to ensure that activities will be confined to the minimum areas required for the works.	Throughout the assessment process, there has been ongoing design iteration to ensure biodiversity is conserved as far as possible. This process has involved engagement with stakeholders on the development of the design. The first priority has been to prevent adverse effects arising. For example, by moving from foreshore locations to inland sites, for example from Cremorne foreshore to an inland location at Cremorne Wharf and from Borthwick Wharf to Deptford Church Street. The location of drive sites in wharf locations has also helped to avoid adverse effects. Where sites are located in the foreshore, this is due to a lack of suitable inland alternatives. For these sites, the project has sought to reduce adverse effects as far as practicable by	Section 5.2 of Vols 3 to 27 describes measures which form part of the proposed development relevant to aquatic ecology. The approach to mitigation hierarchy is described in Vol 2 Section 5.10, with further details in Vol 2 Appendix C.3. The legal and policy drivers underlying the approach to mitigation are described in Vol 2 para.5.3.22.

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
	keeping the extent of works as compact as possible. Opportunities to enhance biodiversity have been built into the proposed development where practicable, for example through provision of fendering and inter-tidal terraces at foreshore sites. Where it has not been possible to avoid loss of aquatic habitat, in consultation with the Environment Agency, the project has adopted a mitigation hierarchy.	
In taking decisions, the **decision maker** should ensure that appropriate weight is attached to designated sites of international, national and local importance; protected species; habitats and other species of principal importance for the conservation of biodiversity; and to biodiversity and geological interests within the wider environment.	The project has adopted a methodology for evaluating receptors which is based on both established sectoral guidance and previous EIA's for developments in the tidal Thames. The value and sensitivity of individual receptors are considered together with the magnitude of an impact in order to determine the significance of effects upon them. Appropriate mitigation and compensation has been devised for moderate and major adverse effects.	The assessment methodology is presented in this section.
Under s125 and 126 of the Marine and Coastal Access Act, the **decision maker** must further the conservation objectives of any relevant MCZs and, where this is not possible, exercise its functions in a manner	In the context of Marine Conservation zones the term objective refers to the 'desired quality' of the feature(s) for which the site is designated[i]. The tidal Thames is part of the proposed South East Marine Conservation Zone. The proposed MCZ comprises a	The Thames Estuary MCZ is described in the project wide baseline in Section 5.4 of Vol 3 Project-wide effects assessment.

[i] Balanced Seas (2011) Marine Conservation Zone Project: Final Recommendations.

Requirements of the NPS	**How the requirement is addressed**	**Location of where to find further detail**
which least hinders the achievement of conservation objectives.	number of intertidal and subtidal habitats and various species including smelt and European eel. In most cases the objective is to maintain these features, and in some cases to ensure recovery. The project wide assessment (Vol 3) concludes that the Thames Tideway Tunnel project would not hinder these objectives. Improvements in dissolved oxygen arising from operation of the project are expected to contribute to the achievement of the conservation objectives for smelt and European eel.	
The **applicant** should be particularly careful to identify any effects of physical changes on the integrity and special features of Marine Nature Reserves and their proposed successor Marine Conservation Zones.	The habitats designated within the Thames Estuary Marine Conservation zone lie in the outer Estuary and would not be subject to impacts as a result of construction of the Thames Tideway Tunnel project. There is the potential for temporary impacts on spawning habitat of smelt in the upper estuary, which has been assessed.	The Thames Estuary MCZ is described in the project wide baseline in Section 5.4 of Vol 3 Project-wide effects assessment.
The **applicant** should demonstrate that during construction and operation, best practice will be followed to ensure that risk of disturbance or damage to species or habitats is minimised, including as a consequence of transport access arrangements.	The *CoCP* sets out the best practice and project specific measures to be implemented during the construction phase to ensure that the risk of disturbance or damage to species or habitats is minimised. Within the *CoCP* there is a requirement for the contractor to produce a Landscape and Ecology Management plan for each site, demonstrating how each of the measures set out in the *CoCP* will be implemented on site during construction.	*CoCP* Part A and Part B Section 11
The IPC should ensure that applicants have	A Landscape and Ecology Management Plan will be	*CoCP* Part A Section 11

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
restoration plans for areas of foreshore disturbed by direct works.	prepared for the project, as detailed in the Section 11 of *CoCP* Part A. The approach to foreshore reinstatement is detailed in a method statement appended to the project wide assessment.	Vol 3 Appendix C.4

5.4 Baseline data collection

5.4.1 The assessment is based on field survey data collected for the project, and background data obtained from desk study. The scope and methodologies adopted for the field surveys have been discussed with the EA. Survey methodologies are based on published good practice which are referenced below where appropriate.

Desk based baseline data

5.4.2 Desk based baseline data has been collected between 2010 and 2012. The data sets are described below Vol 2 Table 5.4.1.

Designated sites

5.4.3 Details of statutory (designated under law) and non-statutory (designated purely through policy) designated sites, including site descriptions and boundaries have been obtained from Greenspace Information for Greater London (GiGL)[9].

Habitats

5.4.4 *Biodiversity Action Plans* have been sourced from local authority websites, and through websites for organisations such as the London Biodiversity Partnership and Thames Estuary Partnership. These data have been used to identify locations of *BAP* habitats within the survey areas.

Mammals

5.4.5 Information regarding cetaceans (whales and dolphins) and other marine mammals has been obtained from three sources; Zoological Society of London, British Divers Marine Life Rescue and Essex Biodiversity Partnership (the latter of whom hold data for the outer Thames Estuary). Data is available for the past ten years and includes anecdotal records of whales, dolphins, porpoises and seals throughout the tidal Thames.

Fish

5.4.6 The EA also undertakes a long term monitoring programme for fish. Surveys have been carried out using various methods (beam trawling, beach seining and hand net kick-sampling) from between 1964 and 2011. Details of these techniques are provided in Vol 2 Appendix C.2. The EA survey programme covers a series of six sites through the Thames estuary from Richmond to West Thurrock (Vol 2 Figure 5.4.1 [see separate volume of figures]), although only three of these sites (Kew, Battersea and Greenwich) have been sampled continuously throughout the 1964 to 2011 period. Although the sampling points are dispersed too widely through the estuary to provide a baseline for the site-specific assessments for this project, the data is valuable as a basis for identifying long term trends and has been used to examine field surveys in the context of longer term data sources.

Invertebrates

5.4.7 The Thames Estuary Benthic Programme (TEBP) was established in 1989 to determine the current pollution status of the Thames estuary, as reflected by benthic macroinvertebrate community structure, and to provide a baseline to monitor changes in ambient water quality. Sampling stations have been set up at 34 sites along the estuary, from the upstream tidal limit at Teddington Weir, to the downstream limit at Sea Reach Number 2 channel marker buoy at the north of the outer estuary. The location of the 10 sites for which data has been used in this assessment is illustrated in Vol 2 Figure 5.4.2 (see separate volume of figures).

5.4.8 Samples have been taken from the intertidal zone, using core and kick samples, where the sediments were firm enough, while in soft sediments sub-tidal day grab or core samples have been taken from a boat. A small number of samples have been also taken with a dredge. Details of the survey methods are presented in Vol 2 Appendix C.2. The results cover the period from 1989 to 2011, although not all sites have been sampled in any one-year. Sampling and analytical methods have varied with time, requiring care in interpretation as has been done in this assessment.

5.4.9 The EA has also supplied data on invertebrate samples identified to family level (a family being a taxonomic level, or grouping of species, below order and above genus) taken during the Teddington Low Flow Survey of 1994-95 in which quarterly samples have been taken at a number of sites in the upper tidal Thames.

Algae

5.4.10 Data has been received from the Natural History Museum, London (NHM) that identifies records of marine algae received for the period from the early 1970s to 1999. This provided existing known records of algae that may be of ecological value.

Summary of information sources

5.4.11 Vol 2 Table 5.4.1 provides the data sources used for collecting desk based baseline data for the assessment. Data used to inform specialist studies associated with the assessment, such as the fish impact modelling is cited through references.

Vol 2 Table 5.4.1 Aquatic ecology – desk based baseline data sources

Source	Data	Notes
Greenspace Information for Greater	Information on statutory designated	

Source	Data	Notes
London (GiGL)	sites.	
British Divers Marine Life Rescue	Information regarding cetaceans and other marine mammals.	Data is limited to records since 2003.
Zoological Society of London	Information regarding cetaceans and other marine mammals.	Data is limited to records since 2003.
Essex Biodiversity Partnership	Information regarding cetaceans and other marine mammals.	Data is limited to records since 2003.
EA	Fisheries data for the period between 1964 and 2011.	Routine monitoring of fish populations began in 1964.
	Invertebrate data from the Thames Estuary Benthic Programme Background data for benthic invertebrates.	Data is available for 34 sites along the Thames estuary, relating to the current EA biological monitoring stations. Data collection began in 1989, but there is not a complete dataset for all sites.
Natural History Museum	Data on algae between 1970s and 1999.	
Local authorities, London Biodiversity Partnership and Thames Estuary Partnership	*Biodiversity Action Plans* to identify locations of *BAP* habitats within the survey areas.	

Field survey baseline data

5.4.12 The EA background data sets for fish and invertebrates provide valuable contextual information. However, the distribution of sampling sites used for the EA surveys has been considered inadequate for establishing a detailed baseline at each of the sites where there would either be construction work on the foreshore, or a CSO discharge point where improvements in water quality are predicted. A programme of field surveys has been therefore undertaken between autumn 2010 and spring 2012.

5.4.13 The following section summarises the surveys undertaken for each of the aquatic ecology receptors. Full details of the methodologies are provided in Vol 2 Appendix C.2 Scope of surveys.

Habitats

5.4.14 Habitat surveys were undertaken at all of the foreshore sites during October 2010. Following changes to the scheme arising from phase one consultation a number of new sites (Carnwath Road Riverside, Kirtling Street, Heathwall Pumping Station and Chambers Wharf) were surveyed in May 2011. Sites surveyed in 2010 are illustrated in Vol 2 Figure 5.4.3 and 2011 and 2012 sites in Vol 2 Figure 5.4.4 (see separate volume of figures). The aim was to determine the distribution of habitats at each of the sites where there would be works on the foreshore, in order to establish a baseline against which effects can be assessed.

5.4.15 No formal methodology exists for recording intertidal and subtidal habitats. The survey thus comprised mapping habitats according to dominant substrate type (eg, silt, gravel, cobbles) and recording any notable habitat features, such as mud flats. The survey area comprised the land within the limits of land to be acquired and used (LLAU) plus a 100m zone upstream and 100m downstream within the intertidal zone. Surveys were undertaken at low tide to ensure maximum coverage. No surveys were undertaken in the subtidal zone.

Marine mammals

5.4.16 No surveys were undertaken for marine mammals. Assessments are based on desk study data.

Fish

5.4.17 Baseline surveys for fish were undertaken at foreshore sites during October 2010. As for the habitat surveys, a second suite of surveys covering new sites identified following phase one consultation were surveyed in May 2011. The sites are illustrated in Vol 2 Figure 5.4.4 (see separate volume of figures). The timing of the surveys was, in accordance with the EA's scoping opinion which recommended both autumn and spring survey. The survey area comprised the land within the LLAU plus a 100m zone on the riverward side of the LLAU.

5.4.18 The surveys in 2011 also aimed to provide further information on the location of smelt spawning habitat (smelt being a UK *BAP* species that is relatively frequently found in the tidal Thames). Sampling targeted the period when adult fish (especially smelt) are spawning (April to June). Since it had been considered that the area around the CSO discharges is unlikely to offer suitable spawning habitat, additional sites between the CSO locations were selected in the stretch between Putney Bridge and Chelsea Bridge. This is considered to be the most likely spawning area for smelt following discussion with the EA. These survey sites have been referred to as Intermediate sites 1 to 3.

5.4.19 The baseline surveys were based on three methods. An Agassi trawl towed behind a boat was used to sample the subtidal zone on the main tidal Thames. Sampling was undertaken in lines or transects parallel with the shore within the survey area. Sampling in the intertidal zone on the main tidal Thames was undertaken using seine netting. The tidal creeks (Bell Lane Creek for the Dormay Street site and Deptford Creek for

Greenwich Pumping Station) were sampled by electrofishing at low tide. Survey techniques are described in Vol 2 Appendix C.2.

5.4.20 A suite of juvenile fish surveys were undertaken on a monthly basis between May and September 2011, to determine the use of marginal habitat by juvenile fish. This data has been used to inform an assessment of the potential hydraulic effects of the proposed temporary and permanent structures on juvenile migratory fish (paras. 5.8.22 to 5.8.36). The aim of the juvenile fish survey is to examine seasonal changes in the spatial distribution of juvenile fish in the tidal Thames, particularly in the context of migratory behaviour and the need of juvenile fish to pass foreshore construction sites.

5.4.21 The survey covered five sites between Kew and Bermondsey Wall East. The sites were selected in order to cover a selection of Thames Tideway Tunnel project sites, as well as a representation of the range of salinities and habitat types through the tidal Thames. The sites are illustrated in Vol 2 Figure 5.4.4 (see separate volume of figures).

5.4.22 The methods are in conformity with the Environment Agency's Water Framework Directive (WFD) multi-method approach[10], consisting of three sampling techniques:

a. seine netting,

b. Riley push-netting

5.4.23 Seine netting provided a general sample across the marginal zone. Riley push netting allows the surveyor to walk a transect parallel with the shore thus recording fish at fixed depth. Kick netting allowed selective sampling of specific habitat types. Further details of the methods are presented in Vol 2 Appendix C.2.

Invertebrates

5.4.24 Baseline surveys for invertebrates were undertaken at foreshore sites during October 2010. As for the habitat and baseline fish surveys, a second suite of surveys covering new sites identified during phase one consultation were surveyed in May 2011. The sites are illustrated in Vol 2 Appendix C.2. Surveys were undertaken using an air lift sampler for the subtidal zone and kick sampling and quadrat sampling in the intertidal zone.

5.4.25 A further aim of the baseline surveys has been to sample invertebrates at the most polluting of the existing CSO discharges (ie, those greater than 1 million m^3 per year) in order to provide a baseline against which potential improvements following interception of the CSOs could be assessed. These improvement sites were Lots Road Pumping Station, Western Pumping Station and Deptford Storm Relief. Samples were taken in the area in the immediate vicinity of the CSO. Comparison or control samples were also taken outside the zone that would be most directly influenced by the CSO discharge.

Algae

5.4.26 Surveys to sample the species assemblage and distribution of algae at seven of the Thames Tideway Tunnel project foreshore sites were undertaken during May 2012. No formal methodology exists for sampling algae, and thus a semi-quantitative technique which has been used for previous surveys of the tidal Thames was employed. Details of the methodology are presented in Vol 2 Appendix C.2.

5.4.27 The surveys undertaken at each site are summarised in Vol 2 Table 5.4.2 Methodologies for each of these surveys are presented in Vol 2 Appendix C.2. Survey results are presented in the project-wide volume (Vol 3 Appendix C.1) and site-specific volumes (Vol 4-27).

Vol 2 Table 5.4.2 Aquatic ecology – baseline surveys by site

Site	2010 Surveys			2011 Surveys				2012 Surveys
	Habitat	Fish	Inverte-brates	Habitat	Fish	Inverte-brates	Juvenile fish	Algae
Kew							✓	
Hammersmith Pumping Station		✓						
Barn Elms	✓	✓	✓					
Putney Embankment Foreshore	✓	✓	✓		✓ incl. spawning		✓	✓
Intermediate Site 1					✓ incl. spawning			
Bell Lane Creek*	✓		✓		✓			
Intermediate Site 2					✓ incl. spawning			
Carnwath Road				✓	✓	✓		
Kirtling Street				✓	✓	✓		
Heathwall Pumping Station				✓	✓	✓		✓
Cremorne Wharf Depot	✓	✓	✓					
Jews Row**	✓	✓	✓					
Lots Road Pumping Station***						✓		

Site	2010 Surveys			2011 Surveys				2012 Surveys
	Habitat	Fish	Inverte-brates	Habitat	Fish	Inverte-brates	Juvenile fish	Algae
Intermediate Site 3					✓ incl. spawning			
Chelsea Embankment Foreshore	✓	✓	✓				✓	✓
Western Pumping Station		✓	✓	✓	✓ incl. spawning	✓		
Tideway Walk****	✓	✓	✓					
Albert Embankment Foreshore	✓	✓	✓					✓
Victoria Embankment Foreshore	✓	✓	✓					✓
Blackfriars Bridge Foreshore	✓	✓	✓				✓	✓
King Edward Memorial Park Foreshore	✓	✓	✓					✓
Bermondsey Wall East*****							✓	
Chambers Wharf				✓	✓	✓		
Borthwick Wharf******	✓	✓	✓					
Deptford Church Street	✓	✓	✓			✓		
Greenwich Pumping Station				✓	✓	✓		
Abbey Mills Pumping Station						✓		

*Relevant to Dormay Street
** Surveyed by not used in assessment.
** *Relevant to Cremorne Wharf

Site	2010 Surveys			2011 Surveys				2012 Surveys
	Habitat	Fish	Inverte-brates	Habitat	Fish	Inverte-brates	Juvenile fish	Algae
****Relevant to both Kirtling Street and Heathwall Pumping Station *****Relevant to Chambers Wharf ******Relevant to Deptford Church Street								

Receptor identification and sensitivity

5.4.28 An ecological resource is defined as a site or area of nature conservation value. The ecological receptors are valued using a geographical scale as per the scales defined in the *IEEM Guidelines* (IEEM, 2006)[11]. To allow for project-wide compatibility, the IEEM terminology has been adapted to align as far as possible with the project terminology (Vol 2 Section 3.7). The relationship between the IEEM terminology and the project terminology is given in Vol 2 Table 5.4.3.

Vol 2 Table 5.4.3 Aquatic ecology – the relationship between ecological receptor values based on IEEM terminology and the project terminology

Ecological receptor value based on IEEM	Ecological receptor value based on project terminology
International	High
National	High
Regional (South East UK)	High
Metropolitan (Greater London)	Medium – high
Borough	Medium
Local	Low – medium
Site	Low. This category is not used in the aquatic ecology assessment because it is not considered relevant and no receptors would fall within it.
No significant resource*	Negligible

** Note the term significant resource is associated with the IEEM guidelines, meaning the resource is valued at a particular geographic scale. Note this is not the same as a significant effect which is defined in Vol 2 Table 5.5.3 below.*

5.4.29 Each site/area may have more than one feature of value that it supports (for example different habitats or populations and/or communities of species). Individual ecological resources and the features that comprise each resource are evaluated according to criteria generally accepted by ecologists, including designation and protection status (see Section 5.3). To attain each level of value or importance, an ecological resource or feature should meet the criteria set out in Vol 2 Table 5.4.4.

5.4.30 In some cases, professional judgement is required to increase or decrease the allocation of specific value designated to each resource. This judgement is based on consideration of the following additional criteria:

a. population trends

b. sustainability of resource

c. representativeness

d. potential for substitution/re-creation

e. position in the ecological unit

f. biodiversity value (Ratcliffe, D., 1977)[12].

5.4.31 The evaluation criteria used are presented in Vol 2 Table 5.4.4. These have been developed for other sewage treatment works projects in the tidal Thames (such as the Lee Tunnel project).

Vol 2 Table 5.4.4 Aquatic ecology – receptor value/sensitivity criteria

Receptor value and/or sensitivity	Definition
High (International)	A habitat or biosphere cited as a reason for the designation or proposed designation of a World Heritage Site, Biosphere Reserve, Biogenetic Reserve, Ramsar site, Special Protection Area (SPA) or Special Area of Conservation (SAC). A large extent of habitat that is listed as a Priority Habitat Type in Annex 1 of the EC Habitats Directive in good condition with typical species diversity. A large and viable population of a regularly occurring species that is rare within an international context. Species listed in Annex II or Annex IV of the Habitats Directive.
High (National)	A habitat or species cited as the reason for the designation or proposed designation of a National Nature Reserve (NNR), Marine Nature Reserve, Marine Conservation Area, Marine Conservation Zone (MCZ) and Site of Special Scientific Interest (SSSI). Any area of habitat listed as a Priority Habitat Type in Annex 1 of the EC Habitats Directive that has potential to support typical species diversity (that would not qualify for designation at international level). A large extent of habitat listed as a Priority Habitat in the UK BAP in good condition that supports an abundance of typical species. A large and viable population of a regularly occurring species that is scarce within an international context A very large and viable population of a regularly occurring species that is listed as a Priority Species in the UK BAP. A large and viable population of a regularly occurring rare species that occurs in 15 or fewer 10km squares of the National Grid (eg, a species that is listed in UK Red Data Books). A substantial proportion of a nationally important species and the habitat that supports that substantial proportion eg European eel which receives protection under the Eels (England and Wales) Regulations 2009. Species listed on Schedules 5 and 8 of the Wildlife and Countryside Act 1981. Other species listed as occurring in 15 or fewer 10km squares in the UK.
High (Regional)	. A substantial proportion of the regional resource of a UK *BAP* habitat or a key habitat identified in a regional

Receptor value and/or sensitivity	Definition
	BAP. A substantial proportion of the regional population of a species listed in a regional *BAP* or relevant designated Natural Area on account of its regional rarity or localisation. Other UK Red Data Book species. A large and viable population of a plant species that is known to occur in 16 to100 10km squares of the National Grid (Stewart A, et al, 2004). A large and viable population of a regularly occurring insect species (Nationally Notable categories Na and Nb) that is known to occur in 16 to 100 10km squares of the National Grid. Sites supporting >1% of a regional population.
Medium-high (Metropolitan)	A nature reserve designated at any other level that no longer meets the criteria for their designation, but meets the criteria for designation as a SINC (Grade M)[ii]. A Local Nature Reserve (LNR) designated as one of the best examples of habitats and/or species assemblages in the metropolitan area. Habitats and/or species cited as the reason for or that would meet the criteria for Local Wildlife Site designation as a SINC (Grade M). Viable populations of the following species: a. Species listed in a County or Metropolitan Red Data Book or *BAP* on account of its rarity/localisation in a county context. b. Sites supporting 1% or more of a metropolitan population.
Medium (Borough)	A nature reserve designated at any other level that no longer meets the criteria for their designation, but meets

[ii] SINC (Grade M) = Site of Importance for Nature Conservation (Grade III of Metropolitan importance). These are sites that provide significant contributions to the ecology of the London Metropolitan area. Selection is based on the availability of similar habitat within this area and the geographic relationship with nearby wildlife sites. This includes good examples of habitats listed on the London BAP and areas of UK BAP habitat that are large in extent within the context of London. A UK BAP habitat that is large in extent within the Regional context but is in an unfavourable condition would also be considered to be of Metropolitan value.

Receptor value and/or sensitivity	Definition
	the criteria for designation as a SINC (Grade B[iii]). A Local Nature Reserve (LNR) designated as one of the best examples of habitats and/or species assemblages in the Borough. Habitats and/or species cited as the reason for or that would meet the criteria for Local Wildlife Site designation as a SINC (Grade B). Sites/features that are scarce within the district or that appreciably enrich the district/borough habitat resource. Viable populations of the following species: a. Species listed in a district/borough *BAP* on account of its rarity/localisation in a district context. b. Sites supporting 1% or more of a borough population.
Low-medium (Local)	Habitat and/or species cited as a reason for the designation of a Local Wildlife Site as a SINC (Grade L)[iv]. A nature reserve designated at any other level that no longer meets the criteria for their designation, but meets the criteria for designation as a SINC (Grade L). A good example of a habitat, an assemblage of habitats, or population of species that appreciably enriches the local habitat resource.
Negligible (no significant resource)	No significant ecological value, for example a channelised watercourse with concrete beds and banks.

[iii] SINC (Grade B) = Site of Importance for Nature Conservation (Grade II of Borough importance). These are sites that provide significant contributions to the ecology of the Borough. Selection is based on the availability of similar habitat in the Borough and the geographic relationship with nearby wildlife sites. This includes good examples of habitats listed on the Borough BAP.

[iv] SINC (Grade L) = Site of Importance for Nature Conservation (Grade I of Local importance). These are sites that provide significant contributions to the ecology of the local area and usually have other values such as nature study resources or they are run by local community groups. Selection is based on the availability of similar habitat in the local context and the relationship with nearby wildlife sites.

Base case

5.4.32 Base case schemes have been identified where they would change the baseline for aquatic ecology receptors, primarily through changes in water quality resulting from other waste water related schemes but also from adjacent development schemes. The base case water quality conditions in the tidal Thames in Year 1 and Year 6 (para. 5.6.1) of operation are expected to have undergone a recovery as a result of the Lee Tunnel scheme and upgrades at the main sewage treatment works (STW) at Mogden in the upper Thames Tideway and Beckton and Crossness in the mid Thames Tideway and Long Reach. The Lee Tunnel scheme will intercept the CSO at Abbey Mills, which accounts for nearly half of the CSO discharges to the tidal Thames. The STW upgrades will improve the quality of the treated effluent entering the tidal Thames. As a result of the Lee Tunnel and sewage treatment works upgrade schemes there will be a significant reduction in the occurrence of summer fish-kill events resulting from low dissolved oxygen (hypoxia), and the enhanced dissolved oxygen conditions will improve the ability of fish to migrate through the tidal Thames. Changes in invertebrate communities are anticipated to be less marked, but will include an increase in the occurrence of pollution sensitive species and an increase in the diversity of invertebrate communities.

5.4.33 However, apart from the Abbey Mills CSO, these schemes will not stop the CSO discharges into the river. Thus improvements in the local area of the other CSO discharges will be limited and the increases in dissolved oxygen concentration required for the tidal Thames to meet WFD standards will not be achieved.

5.5 Construction effects assessment

5.5.1 This section describes the methodology for assessing effects on aquatic ecology during construction. This applies only to sites with construction works taking place in the river. The methodology for assessing operation, cumulative and project-wide effects are presented in Sections 5.6 to 5.8.

Assessment years

5.5.2 The assessment of construction effects is based on Site Year 1 of construction in which site establishment would be taking place and when river based activities, such as piling and dredging would be at a peak. These activities are considered to carry the greatest potential for causing aquatic ecology effects. The assessment of aquatic ecology effects during construction is of the Thames Tideway Tunnel project against this base case. In addition, consideration is given to the extent to which the construction assessment findings would be likely to vary materially from those assessed should the programme for the Thames Tideway Tunnel project be delayed by approximately one year.

Assessment areas

5.5.3 The following section includes the approach to defining the assessment area for those sites where works would be taking place in the river.

5.5.4 The assessment area for an individual site encompasses an area in which there is potential for effects on aquatic ecology receptors. For construction, the assessment area is defined by the outer extent of any landtake/disturbance caused by the operation of machinery to install the cofferdams, or any new infrastructure and barging. It also includes an area considered through professional judgement to be subject to indirect change (eg, displacement of aquatic ecology receptors from the areas of direct impact). For the purposes of the assessment this is considered to be 100m upstream and 100m downstream of the LLAU indicated on the Construction phases: phase 1 site setup plan for each foreshore site (see separate volume of figures – Section 1).

5.5.5 Predicting the effects arising from all construction sites simultaneously is particularly relevant for mobile receptors such as fish and mammals, since they are likely to encounter and respond to multiple sites during a single migration. These effects are addressed in Volume 3 Project-wide effects assessment. The approach to the project-wide assessment, including the specific techniques used to assess cumulative effects is described in Section 5.8.

Methodology

5.5.6 The methodology for assessing aquatic ecology is based on the standard approach to ecological impact assessment as defined by the IEEM guidance (IEEM, 2006). The methodology has been developed and agreed with consultees (EA and Natural England) for previous projects relating to the Thames Tideway Quality Improvements, such as the Lee Tunnel and Beckton, and Crossness Sewage Treatment Works improvements. It is therefore an appropriate methodology to apply for other projects related to wastewater discharge in the tidal Thames including the Thames Tideway Tunnel.

5.5.7 The methodology consists of evaluating receptors within a defined geographical scale (eg, national, metropolitan or borough). The approach to evaluating receptors is described in para. 5.4.28 and the criteria for evaluation presented in Vol 2 Table 5.4.4.

5.5.8 For the purposes of this assessment, the term impact is used to describe a force which exerts an influence on a receptor, whilst effects are the response of a receptor to an impact.

5.5.9 The magnitude of individual impacts is based on a scale defined in para. 5.5.3 and Vol 2 Table 5.5.2, based on generalised receptor responses. Significance is determined by combining the value of the receptor with the magnitude of the impact. Moderate and major effects are considered to be significant while minor and negligible effects are considered to be not significant. The approach to determining significance is presented in Vol 2 Table 5.5.3.

5.5.10 In most cases impacts arising during the construction and operational stages are considered for a single Thames Tideway Tunnel project site only (eg, Chelsea Embankment Foreshore only) since there is not considered to be an interaction between Thames Tideway Tunnel project sites for aquatic ecology receptors. Where impacts are considered likely across all of the Thames Tideway Tunnel project sites (for example, the possible hydraulic effects of all sites on juvenile fish), these are dealt with in Volume 3 Project-wide.

5.5.11 At Dormay Street, impacts of the interception of the CSO at King Georges Park merit consideration within the Dormay Street assessment. Both CSOs namely the Frogmore Storm Relief – Buckhold Road (at King Georges Park) and the Frogmore Storm Relief – Bell Lane (at Dormay Street) discharge into the River Wandle. Frogmore Storm Relief – Buckhold Road lies upstream of the Frogmore Storm Relief – Bell Lane. Therefore interception of Frogmore Storm Relief – Buckhold Road would have impacts on both flow and water quality at the Dormay Street site. The same approach has not however been applied to the King George's Park *Environmental Statement* volume, since Dormay Street lies downstream of that site (and beyond several tidal weirs).

5.5.12 There is also potential for concurrent effects between the Heathwall Pumping Station and Kirtling Street sites since they lie close to each other. Resulting effects arising from noise and vibration, and changes in the hydraulic regime around the structures have been considered. No other impacts are considered likely to give rise to effects at these sites.

5.5.13 Paras. 5.5.13 to 5.5.34 describes the approach to the assessment of effects on aquatic ecology receptors for an individual site during construction. The impact considered for each of the receptors are summarised in Vol 2 Table 5.5.1.

Habitats

5.5.14 The assessment of effects on habitats at each of the foreshore construction sites is based on survey data collected during October 2010 and May 2011 (para. 5.4.14).

5.5.15 Habitats have been valued based on their designation status and intrinsic value (ie, the value of the habitat as an ecological feature in itself rather than simply in terms of the support it provides for fauna). The assessment at a site-specific level considers the magnitude of losses from individual habitat types due to temporary landtake, disturbance and compaction, scour and increases in suspended sediment

5.5.16 The calculation of temporary landtake is based on the area from the outer edge of the permanent structure to the outer edge of the temporary cofferdam.

5.5.17 Impacts are assessed according to the degree of change they may cause in terms of ecosystem function, their duration and reversibility.

Marine mammals

5.5.18 The assessment of effects on marine mammals is based on background data comprising records obtained for the whole of the Tideway (Vol 2 Table 5.4.1).

5.5.19 Mammals have been evaluated according to the protection status of species recorded at the site and the potential for the site to support any specific features of importance, such as haul out areas for seals. Although the number of records of mammals at a site is considered, the valuation also takes account of the contribution of a site to the tidal Thames as a migratory pathway.

5.5.20 Impacts include temporary landtake, disturbance due to waterborne noise and vibration and increases in suspended sediments. Effects include loss of haul out habitat for seals and interference with migratory movements of marine mammals generally.

5.5.21 Impacts are assessed according to their potential to their duration, seasonal occurrence, reversibility and their potential to cause changes in abundance and distribution.

Fish

5.5.22 The assessment of effects on fish at each of the foreshore sites is based on the baseline survey data for the individual sites. EA background data (Vol 2 Table 5.4.1) and juvenile fish survey data from the closest sampling location to the site in question has also been used to provide further context to the data.

5.5.23 Fish have been evaluated according to the protection status of species recorded at the site, and the diversity of the fish community. Physical factors such as salinity which may limit fish distribution have been considered when placing communities in context.

5.5.24 Impacts include temporary landtake, disturbance and compaction, change to hydraulic regime, and particularly increase in flow velocity around structures. Noise and vibration, increases in suspended sediments and spillage of light into the channel are also considered.

5.5.25 The potential impact of contaminants within sediments has been assessed through reference to known thresholds for individual contaminants known as the Probable Effects Level (PEL). This is the concentration above which adverse effects are most likely to occur if sufficient exposure takes place.

5.5.26 Effects include direct mortality, loss or degradation of feeding, nursery and spawning habitat and disturbance. Increases in flow velocity around the structures have the potential to interfere with the migratory movements of juvenile fish. A modelling approach which simulates the movement of fish through the estuary has been used to assess this impact. The approach is described in para. 5.8.25.

5.5.27 Losses from habitats have been considered in the context of the importance and availability of the habitat for an individual species. Interference with migratory movements has been judged using hydraulic data showing extent of change in velocities in intertidal and subtidal areas.

Invertebrates

5.5.28 The assessment of effects on invertebrates at each of the foreshore sites is based on the baseline survey data for the individual sites. EA background data (Vol 2 Table 5.4.1) from the closest sampling location to the site in question has also been used to provide further context to the data.

5.5.29 Invertebrates have been evaluated based on rarity status and diversity, and abundance of communities. The presence of pollution sensitive species has been used as a measure of value.

5.5.30 Impacts include temporary landtake, disturbance and compaction and increases in suspended sediment. Effects include temporary losses of habitat and blanketing of substrates and interference with feeding mechanisms due to suspended sediments.

5.5.31 Losses from habitats have been considered in the context of the importance and availability of the habitat. Benefits have been assessed in terms of predicted changes in community abundance and composition. Individual species and groups considered either to be indicators of pollution or of recovering conditions have been highlighted.

Algae

5.5.32 The assessment of effects on algae is based on survey data at each of the foreshore sites. Background data (Vol 2 Table 5.4.1) from the closest sampling location to the site in question has also been used to provide further context to the data.

5.5.33 Algal communities have been evaluated according to species rarity status and overall habitat value. Algal mats provide refuges and feeding habitat for fish and invertebrates and their value, is recognised in the *Tidal Thames Habitat Action Plan (*Thames Estuary Partnership Biodiversity Action Group , 2002)[13].

5.5.34 Impacts include temporary landtake, and increases in suspended sediment. Effects include loss of existing algal communities, and potential for colonisation of new habitats.

Vol 2 Table 5.5.1 Aquatic ecology – impacts on individual receptors

Impact	Receptor				
	Habitats	Mammals	Fish	Invertebrates	Algae
Temporary landtake	✓	✓	✓	✓	✓
Disturbance and compaction	✓		✓	✓	
Change to hydraulic regime and scour	✓		✓		
Disturbance due to waterborne noise and vibration		✓	✓		
Increase in suspended sediment	✓	✓	✓	✓	✓
Spillage of light into riverine habitat			✓		

Significance criteria

5.5.35 The likely significant effects on aquatic ecology have been determined with reference to the guidelines published by IEEM (2006). The level of significance is derived from measures of the magnitude of impact and the sensitivity of the receptors affected as described below.

Determining magnitude of impacts

5.5.36 No standard methodology exists for determining and describing the magnitudes of ecological impacts. The *IEEM Guidelines* (2006) identify a number of parameters which should be considered in defining impact magnitude including extent, duration, reversibility, timing and frequency. The impact magnitude criteria presented below have been developed for previous aquatic ecology assessments on the tidal Thames, including the Lee Tunnel and Beckton scheme and the Crossness sewage treatment works upgrade.

5.5.37 The terms high negative, medium negative, low negative, negligible, low positive, medium positive, and high positive are used to assess the magnitude of the impact on receptors. The impact magnitude criteria are presented in the table below and apply to the assessment of both construction and operation.

Vol 2 Table 5.5.2 Aquatic ecology – impact magnitude criteria

Impact magnitude	Definition
High negative	Disruption of ecosystem functioning through loss of species and loss of diversity. Changes may be long lasting (greater than 10 years) or permanent, particularly if loss or major alteration of wildlife habitat occurs. Recovery, if possible, is likely to take more than 5 years. Results in permanent loss of attributes.
Medium negative	Smaller scale change occurs. The abundance of some of the more sensitive species may be reduced. Changes in habitat may be longer lasting (7 – 10 years). Impact is substantially reversible, although recovery may take 1 to 5 years following cessation of impact.
Low negative	Some changes in species/habitat abundance may occur, but the impact is reversible. Full recovery is likely in the short term (up to 1 year), following the cessation of impact.
Negligible	The chance of any impact is very low and if it occurs it is well below the level of detection.
Low positive	Some increases in species abundance may occur but such changes are relatively local
Medium positive	Smaller scale change occurs. The abundance of some of the more sensitive species increases more widely. Changes in habitat should be longer lasting and less prone to detrimental impacts.

Impact magnitude	Definition
High positive	Substantial change of ecosystem functioning, with gain of species and gain of diversity, notably rarer more sensitive species. Changes should generally be long lasting or permanent.

5.5.38 For the site-specific assessments impact magnitudes for the construction are applied in accordance with the criteria in Vol 2 Table 5.5.2.

Defining effects

5.5.39 Ecological effects are described separately for each individual receptor, and any interactions between receptors highlighted (eg, between benthic invertebrates and waterfowl). The significance of effects is determined using the matrix presented in Vol 2 Table 5.5.3, in which the value of the receptor is combined with the magnitude of the impact to give a level of effect. The matrix has been developed and tested on a variety of ecological impact assessments, including three major Thames Tideway Quality Improvements schemes (see para. 5.5.6).

5.5.40 The probability of an effect occurring, and confidence in the prediction is expressed using the following defined scale:

a. certain/near-certain: probability estimated at 95% chance or higher

b. probable: probability estimated above 50% but below 95%

c. unlikely: probability estimated above 5% but less than 50%

d. extremely unlikely: probability estimated at less than 5%.

5.5.41 The types of effects and the probability and confidence associated with the prediction outlined above are taken from the *IEEM guidelines* (2006).

Determining significance of effects

5.5.42 The significance of aquatic ecology effects have been determined by combining the identified impact magnitudes with the receptors (and their sensitivity) affected by those impacts (taking account of their sensitivity), as set out in Vol 2 Table 5.5.3. This applies to the assessment of both construction and operation. The matrix is intended as a guide, and it has been interpreted with ecological judgment where appropriate. There may be instances in which the particular circumstances justify a deviation from this table. In all instances such a deviation is explained in the assessment text.

Vol 2 Table 5.5.3 Aquatic ecology – significance of effect matrix

Magnitude of impact	Receptor value						
	High (international)	High (national)	High (regional)	Medium-high (metropolitan)	Medium (borough)	Low-medium (local)	Negligible
High (positive or negative)	Major	Major	Major/ Moderate	Moderate	Moderate	Moderate / minor	Negligible
Medium (positive or negative)	Major	Major/ Moderate	Moderate	Moderate	Minor	Minor	Negligible
Low (positive or negative)	Major/ Moderate	Moderate	Moderate	Minor	Negligible	Negligible	Negligible
Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible

5.6 Operational effects assessment

Assessment years

5.6.1 The assessment years for the operational assessment of aquatic ecology are:

a. Year 1 of operation, when the project becomes operational

b. Year 6 of operation when it is considered that there would have been a measurable recovery of receptor communities.

5.6.2 The assessment of aquatic ecology is of the Thames Tideway project against the base case in both these years. While the permanent land take effects occur at the start of construction (para. 5.5.16), they are considered in Year 1 of the operational assessment along with all other operational effects. In addition, consideration is given to the extent to which the operational assessment findings would be likely to vary materially from those assessed should the programme for the Thames Tideway Tunnel project be delayed by approximately one year.

Assessment areas

5.6.3 The assessment has considered effects on receptors within the local area which is defined as 100m upstream and 100m downstream of the maximum extent of the permanent works. Beyond this zone tidal currents would result in mixing and dispersal of the effluent. Effects beyond this zone are thus considered at a project-wide level.

Methodology

5.6.4 The approach to valuing receptors and assessing the magnitude of impacts is presented in Vol 2 Table 5.4.4 and Vol 2 Table 5.5.2. The operational assessment considers the following impacts:

a. Increases in dissolved oxygen concentrations in the vicinity of the CSO

b. Reduction in sediment nutrient levels

c. Reduced levels of sewage derived litter

d. Permanent landtake - infrastructure provision for barges

5.6.5 The impacts on each receptor are summarised in Vol 2 Table 5.6.1.

Vol 2 Table 5.6.1 Aquatic ecology – impacts on individual receptors

Impact	Receptor				
	Habitats	Mammals	Fish	Inverte-brates	Algae
DO increases near CSO					
Reduction in sediment nutrient levels	✓		✓	✓	✓
Reduction in sewage derived litter	✓	✓			
Permanent landtake	✓	✓	✓	✓	✓
Modification to habitats due to scour protection	✓		✓	✓	✓

Habitats

5.6.6 The assessment of operational effects on habitats at Thames Tideway Tunnel project foreshore sites is based on survey data collected in October 2010 and May 2011. At non-foreshore sites the assessment is based on data from the nearest foreshore site.

5.6.7 Impacts on habitats include reductions in sediment nutrients and sewage derived litter, permanent landtake and modification to habitats due to scour protection.

5.6.8 Effects include improvements in habitat quality, permanent loss of habitat and change in the function of habitats due to scour protection.

Marine mammals

5.6.9 The assessment of effects on marine mammals is based on background data comprising records obtained for the whole of the Tideway (Vol 2 Table 5.4.1).

5.6.10 Impacts include reductions in sewage derived litter and permanent landtake. Effects include reductions in mortalities as a result of ingesting litter and potential loss of haul out habitats for seals. Benefits have been considered in terms of potential improvements to survival and reproductive success.

Fish

5.6.11 The assessment of operational effects on fish at each of the foreshore sites is based on the baseline survey data for the individual sites. EA background data (Vol 2 Table 5.4.1) and juvenile fish survey data from the closest sampling location to the site in question has also been used to provide further context to the data. At non-foreshore sites the assessment is based on EA background data and survey data from the nearest Thames Tideway Tunnel project site.

5.6.12 Impacts include increases in dissolved oxygen concentrations in the vicinity of CSOs, reductions in nutrients, permanent landtake and modifications to habitats due to scour protection.

5.6.13 Beneficial effects include reductions in hypoxia (ie, mortality due to low dissolved oxygen) leading to sustainability of fish populations, increases in the distribution of pollution sensitive species. Reductions in hypoxia cannot be measured at a site-specific level and are thus considered with reference to modelled predictions of reductions in hypoxia for the whole Thames Tideway using the Tideway Fish Risk Model described in para. 5.8.17.

5.6.14 Permanent landtake would lead to loss of intertidal and marginal habitats. Modification of habitats may lead to an increase in the availability of refuges for juvenile fish, but a decrease in invertebrate feeding resource in those affected areas. Losses from habitats have been considered in the context of the importance and availability of the habitat.

Invertebrates

5.6.15 The assessment of effects on invertebrates at each of the foreshore sites is based on the baseline survey data for the individual sites. EA background data (Vol 2 Table 5.4.1) from the closest sampling location to the site in question has also been used to provide further context to the data. At non-foreshore sites the assessment is based on EA background data and survey data from the nearest Thames Tideway Tunnel project site.

5.6.16 Impacts include improvements in dissolved oxygen concentrations, reductions in sediment nutrients and sewage derived litter, permanent landtake and modifications to habitats due to scour protection.

5.6.17 Losses from habitats have been considered in the context of the importance and availability of the habitat. Benefits have been assessed in terms of predicted changes in community abundance and composition. Individual species and groups considered either to be indicators of pollution or of recovering conditions have been highlighted.

Algae

5.6.18 The assessments of operational effects on algae are based on survey data at each of the foreshore sites. Background data (Vol 2 Table 5.4.1) from the closest sampling location to the site in question has also been used to provide further context to the data. At non-foreshore sites the assessment is based on EA background data and survey data from the nearest Thames Tideway Tunnel project site.

5.6.19 Impacts include reductions in sediment nutrients and sewage derived litter, permanent landtake and modifications to habitats due to scour protection.

5.6.20 Effects include changes to community composition due to improved water quality. The nature of the permanent structures is considered in terms of their potential as a colonising surface for algae.

Significance criteria

5.6.21 The significance of aquatic ecology effects during operation have been determined using the same matrix presented in Vol 2 Table 5.5.3.

5.7 Cumulative effects assessment

5.7.1 The general approach to assessing cumulative effects is described in Section 3 General EIA methodology. The specific approach for aquatic ecology is described below. The assessment years considered for the cumulative effects assessment remain as defined in Sections 5.5 and 5.6 above.

5.7.2 Cumulative effects are considered with other developments which may affect aquatic ecology receptors. The assessment is undertaken qualitatively using judgement to consider whether the findings of the core assessment on significance of effects are altered by the cumulative assessment. Any significant effects are described although they are not reclassified using the significance criteria described in Vol 2 Table 5.5.3.

Site cumulative effects

5.7.3 The assessment of cumulative effects considers the potential for effects arising from a single Thames Tideway Tunnel project site to accumulate with effects from other non-Thames Tideway Tunnel developments. The aquatic ecology assessment is concerned with in-river development, development adjacent to the river or development discharging into the river. Sites within the development schedules for each site (Appendix N of Vols 4 to 27) which fall within these categories have been assessed. All other land-based developments have been excluded on the basis that would not lead to likely significant aquatic ecology effects.

5.7.4 This would be particularly important for mobile receptors such as fish which may experience a series of impacts during a single migration. In assessing the potential for cumulative effects consideration has been given to:

a. the scale, number and proximity of the other development(s)

b. the timing of the construction period in relation to the Thames Tideway Tunnel project site

c. the nature of the construction activity

d. the sensitivity of receptors within the assessment area for that site.

5.7.5 Effects of other developments are considered qualitatively using professional judgement and are reported according to whether they elevate or reduce the significance of an effect in comparison with the Thames Tideway Tunnel project alone.

5.8 Project-wide effects assessment

5.8.1 The general approach to assessing the likely significant effects, including project-wide effects, is described in Section 3. The specific approach for assessing project-wide aquatic ecology effects is described below.

5.8.2 Project-wide effects are those effects on a receptor, eg, a fish species that could arise from all (or the majority) of Thames Tideway Tunnel project sites. The aspects of the project which could give rise to project-wide effects are listed in para. 5.8.8.

Assessment years

5.8.3 The assessment year for construction is taken to be Project Year 1 of construction with all sites active and those activities with the greatest potential for impacts such as piling would be taking place.

5.8.4 There are two assessment years for the operational assessment:

a. Year 1 when the project becomes operational

b. Year 6 when it is considered that there would have been a measurable recovery of receptor communities.

5.8.5 The assessment of aquatic ecology effects compares these assessment years against the base case. The assumptions regarding base case conditions outlined in paras. 5.4.32 to 5.4.33 applies to the project-wide assessment.

Assessment areas

5.8.6 The area for the project-wide assessment includes the complete extent of the tidal Thames from the tidal limit at Teddington Weir to the inner limit of the outer Thames Estuary as shown in Vol 2 Figure 5.8.1 (see separate volume of figures).

Methodology

5.8.7 The same method has been used to scale the magnitude of impacts and evaluate resources as for the site-specific assessments Vol 2 Table 5.5.2 and Vol 2 Table 5.5.3.

5.8.8 The project-wide assessment identifies effects on aquatic ecology receptors arising from:

a. all of the Thames Tideway Tunnel project foreshore sites under simultaneous construction

b. the river-wide effects arising from interception of all CSO discharges

c. the effects of other (ie, non-Thames Tideway Tunnel project) in-river developments in cumulation with the Thames Tideway Tunnel project sites as part of the cumulative effects assessment.

5.8.9 The approach to assessing project-wide effects is described below for habitats, marine mammals, fish, invertebrates and algae.

Habitats

5.8.10 The project-wide assessment is based on habitat data collected from all of the Thames Tideway Tunnel project foreshore sites and information from *Borough Biodiversity Action Plans* (*BAPs*) and habitat action plans (HAPs) for the tidal Thames.

5.8.11 The project-wide assessment considers:

a. the river-wide effects of improved water quality on intertidal and subtidal habitats

b. overall loss of intertidal and subtidal habitats due to temporary and permanent structures on the foreshore

c. changes to habitat structure and function due to scour and accretion arising from the Thames Tideway Tunnel project structures.

Marine mammals

5.8.12 The project-wide assessment is based on background data comprising records obtained for the whole of the Tideway (Vol 2 Table 5.4.1).

5.8.13 The project-wide assessment considers:

a. the river-wide effects of improved water quality on marine mammals associated with the tidal Thames

b. overall loss of intertidal and subtidal habitats which may be used by marine mammals

c. effects of noise, lighting and other potential sources of disturbance on marine mammals.

Fish

5.8.14 The project-wide assessment is based on the baseline survey data collected from all of the Thames Tideway Tunnel project foreshore sites. EA background data (Vol 2 Table 5.4.1) and juvenile fish survey data has also been used to provide further context to the data.

5.8.15 The project-wide assessment considers:

a. the river-wide effects of improved water quality on fish populations associated with the tidal Thames

b. overall loss of intertidal and subtidal habitats due to temporary and permanent structures on the foreshore

c. effects of noise, lighting and other potential sources of disturbance on fish

d. the hydraulic effects of temporary and permanent structures on the foreshore on juvenile fish migrations. Increases in flow velocity around the structures have the potential to interfere with the migratory movements of juvenile fish. A modelling approach which simulates the movement of fish through the estuary has been used to assess this impact. The approach is described in para. 5.8.25.

5.8.16 The specific analytical techniques used to assess effects on fish are described below.

Assessing effects arising from water quality improvements

5.8.17 The presence of untreated sewage effluent in the aquatic environment can result in low levels of dissolved oxygen, which can cause mass fish mortalities known as hypoxia events. The Tideway Fish Risk Model (TFRM) is a computer model developed to predict and assess the effect of hypoxia on existing fish populations in the tidal Thames. The model uses existing fish population data and compares it with water quality data for the same period. The model divides the river into the 3km stretches which are used as a basis for water quality monitoring.

5.8.18 It was used to develop dissolved oxygen (DO) standards for the tidal Thames (Turnpenny *et al.*, 2004)[14] as part of the *Thames Tideway Strategic Study*. Details of the development of the model are described in Vol 3. The dissolved oxygen standards are described in Vol 2 Section 14 (Water Resources - Surface Water).

5.8.19 The model was run for a series of water quality improvement scenarios which included the upgrades of the five Tideway sewage treatment works (Mogden, Beckton, Crossness, Riverside and Long Reach), the Lee Tunnel, and the Thames Tideway Tunnel project.

5.8.20 The predictions of the benefits of the water quality improvements of the Thames Tideway Tunnel project on fish populations described in this assessment have been based on outputs from the TFRM (Turnpenny *et al.*, 2004)[15].

5.8.21 The assumptions of the TFRM and the baseline data on which it has been based have been updated as part of the operational assessment for this project. For example, the model is based on long term EA monitoring data, which is obtained from a limited number of sites. Baseline surveys for the project cover a wider range of sites, and hence have helped to improve the accuracy of the model. A description of the model and the outputs from it are included in Vol 2 Appendix C.4.

Assessing effects on juvenile fish migrations

5.8.22 One of the potential impacts on fish populations is the interference to juvenile fish migrations by the encroachment of temporary and permanent structures into the intertidal zone. Juvenile fish are weaker swimmers than adult fish and depend on this zone for shelter from strong tidal currents and as a refuge from predatory adult fish. The effect of this impact could be to reduce population size by direct mortality, or by preventing fish from reaching essential feeding or spawning habitat.

5.8.23 A computer modelling technique has been used to simulate the response of fish populations to a series of structures encroaching into the channel. Since this is a relatively novel technique for ecological impact assessment in the UK, a literature review has been undertaken in order to identify the most appropriate modelling technique. The review is presented in Vol 2 Appendix C.4.

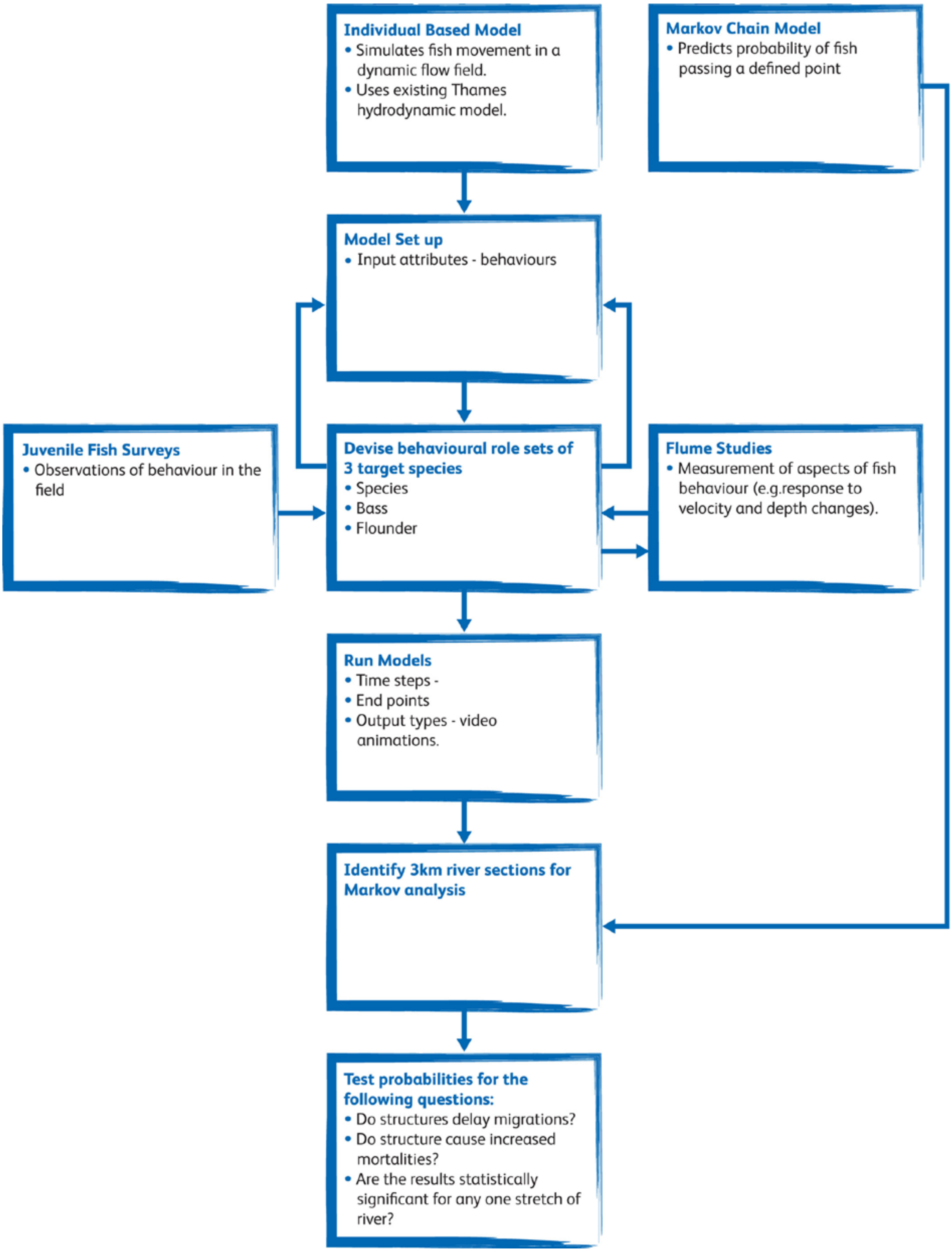
5.8.24 Based on the literature review, two fish migration models have been developed to assess the cumulative impacts of the Thames Tideway Tunnel project foreshore structures:

a. individual-based model (IBM)

b. Markov chain model.

5.8.25 The rationale for selection of the model types and details of them are summarised below. Outputs from the models are used to inform the assessment of hydraulic effects on juvenile fish migrations presented in the project-wide assessment. A full description of the techniques and the outcomes of the modelling study are presented in Vol 3. The modelling process is summarised in Vol 2 Plate 5.8.1.

Vol 2 Plate 5.8.1 Aquatic ecology – fish modelling process



Individual-based model

5.8.26 This technique simulates the migratory movements of fish through the estuary using the existing hydraulic model for the tidal Thames. Particles or surrogate fish are introduced into model which incorporates the temporary and permanent Thames Tideway Tunnel project structures.

The model can be used to compare the progress of fish through the estuary under the base case (ie, with no Thames Tideway Tunnel project structures) with the temporary Thames Tideway Tunnel project structures in place only and permanent structures only.

5.8.27 In order to produce realistic fish behaviours within the model, the virtual fish are ascribed rules which determine how they would react to factors such as channel edges, water depth, tides and local hydraulic conditions.

5.8.28 Three fish species have been selected to represent the assemblage of species which occur in the tidal Thames, in terms of behaviour and physical morphology. They are:

a. Flounder (*Platichthys flesus*) (flat fish species)

b. Bass (*Dicentrachus labrax)* (round fish species)

c. European eel (*Anguilla anguilla) (*a special case which act similarly to flatfish and interact strongly with the bed and banks).

5.8.29 The behaviours ascribed to the model fish are based on a set of rules derived from a combination of background literature review (Vol 2 Appendix C.4) and field and laboratory studies (see Vol 3 Appendix C.1 for further details). They include predominant direction of migration, maximum swimming speed, and choice of depth.

5.8.30 The juvenile fish surveys undertaken during spring and summer 2011 provided information on distribution, depth preference and seasonality for individual species. The laboratory studies were undertaken using flumes ie, an open, artificial water channel in which the depth and velocity of the water can be controlled. Fish are introduced into the flume and their behaviour recorded as they pass through them using direct observations and cameras. They allow specific aspects of fish behaviour, such as reaction to velocity gradients, to be accurately measured.

5.8.31 The behavioural rule information has been peer reviewed and consulted on with the EA. A complete set of the behavioural rules is presented in Vol 3 Appendix C.1.

5.8.32 A series of questions, based on the effects described in para. 5.8.22, has been posed through the model:

a. Do the Thames Tideway Tunnel project structures delay migration? This is measured by the time taken for the fish to reach a specific endpoint under the base case, the scenario where temporary project structures are in place and the scenario where permanent project structures are in place.

b. Do the structures result in increased mortality rates? This is measured by the proportion of fish to reach the endpoint under the base case, the scenario where temporary project structures are in place and the scenario where permanent project structures are in place.

c. Are results statistically significant for any specific length of river? This is calculated using a different modelling approach, the Markov chain model, which provides probabilities of fish moving through defined reaches of the river (para. 5.8.34)

5.8.33 The answers to these questions are expressed in the outputs from the model as numerical probability values which have been interpreted in the context of the effects on fish populations. The significance of them is assessed in Vol 3.

Markov chain model

5.8.34 This modelling technique predicts the probabilities and timings of fish reaching essential habitat features such as spawning habitat. The Markov model can provide probability information for defined reaches of the tidal Thames. The tidal Thames is divided into 3km sections for the purposes of water quality modelling, and these have been used as the basis of the Tideway Fish Risk Model (TFRM). The Markov model has been used to calculate the probability of individual fish species negotiating structures within each of these 3km sections.

5.8.35 The probabilities derived from the Markov model were used to determine statistically significant differences between:

a. the rate at which fish migrate through the tidal Thames with and without the Thames Tideway Tunnel project structures

b. the mortality rates for the individual fish species with and without the Thames Tideway Tunnel project structures.

5.8.36 These differences have then been considered qualitatively in the context of the criteria described in Vol 2 Table 5.5.2 in order to determine the scale of the impact and thus the significance of the effect (Vol 2 Table 5.5.3).

Invertebrates

5.8.37 The project-wide assessment is based on the baseline survey data for the Thames Tideway Tunnel project foreshore sites. EA background data (Vol 2 Table 5.4.1) has also been used to provide further context to the data.

5.8.38 The project-wide assessment of effects on invertebrates considers:

a. the river-wide effects of improved water quality on invertebrate populations associated with the tidal Thames and wider estuary

b. the cumulative effects of habitat loss associated with the temporary and permanent structures on the foreshore.

Assessing effects of water quality improvements on invertebrates

5.8.39 The assessment uses the EA background data set, as well as data collected for this project to identify temporal trends in species abundance and diversity, and to try to determine the factors influencing them. Specifically, the aims of the study were as follows:

a. Identify invertebrate communities and describe factors that explain differences between them

b. Identify any trends (seasonal or long term) in community structure

c. Assess influence of water quality parameters (dissolved oxygen and ammonia)

d. Predict how communities are likely to change as a result of the Thames Tideway Tunnel project.

5.8.40 The study which informs the assessment of water quality improvements on invertebrates is presented in Vol 3 Appendix C.1. The approach to the assessment is summarised below.

5.8.41 The EA data set comprises sampling information collected since 1989 for a series of sampling sites through the tidal Thames. Ten sampling sites lie within the assessment area for this project. The number of individuals of a particular invertebrate species or taxa is recorded for each sample.

5.8.42 Given the size of the data set statistical techniques are required to determine any trends, patterns and relationships in the data. A series of statistical techniques have been used to analyse the data, including multivariate techniques in which several variables (such as invertebrate abundance and water quality parameters) are overlain on the invertebrate data to determine whether there are relationships between them.

Cluster analysis

5.8.43 Cluster analysis provides a means of identifying any patterns in a data set. For example, samples containing a high number of a particular species or taxa may be grouped together in a cluster. The output is a dendrogram or tree diagram, with clusters of similar samples/sites grouped together. Each of the clusters are joined together by branches, and each of the samples/sites within one cluster by smaller branches. Essentially, the longer the branch (distance) between two samples, or clusters of samples, the more dissimilar they are.

5.8.44 The value of this process is that it breaks the data set down into manageable units and allows the similarities between the samples in an individual cluster to be considered in further detail using different statistical techniques. For example, the reason why the samples cluster in a particular way may relate to abiotic factors (ie, those that do not relate to living organisms) factors such as:

a. longitudinal position within the tidal Thames (and thus saline influence)

b. sample method and sampler

c. level of identification (species, family etc)

d. habitat

e. anthropogenic factors, notably pollution and water quality

f. time of year the sample was taken

g. wet and dry years.

5.8.45 Cluster analysis does not allow information on these abiotic factors to be compared alongside the invertebrate data set and so it is necessary to use other statistical techniques. Two techniques have been selected:

a. **Principal Component Analysis (PCA)**. PCA is used to overlay abiotic factors such as chemical data, time of year, habitat (if available) onto the clusters identified in the cluster analysis. This can help to highlight and visually distinguish possible trends within the data set such as those related to chemical factors/pollution events;

b. **Redundancy analysis (RDA)**. RDA has been used in order to understand the influence of the chemical variables (eg, dissolved oxygen) on the composition/abundances of the invertebrates assemblages sampled, while PCA can only consider these as independent, non-explanatory variables. Actual invertebrate abundances data and presence-absence data were used. Chemical data from nearby sample sites have been used.

5.8.46 The analysis allows any statistically significant relationships (ie, those with a probability of 95% or greater of being true) between the invertebrate data and the environmental factors listed in para. 5.8.44 to be identified. However, this is based on observations and trends in the historic dataset. Whilst this information cannot be used to predict with absolute certainty how the invertebrate communities of the tidal Thames may be affected by the Thames Tideway Tunnel project, in combination with professional judgement they have been used as a basis on which to make qualitative judgements about the scale of the improvements. Impacts, both positive and negative, have been scaled using the criteria described in Vol 2 Table 5.5.2 .

Significance criteria

5.8.47 The likely significant effects on aquatic ecology are as defined in the significance of effects matrix in Vol 2 Table 5.5.3.

Project-wide cumulative effects

5.8.48 The general approach to assessing cumulative effects is described in Section 3 General EIA methodology. The specific approach for aquatic ecology is described below. The assessment years considered for the cumulative effects assessment remain as defined in Sections 5.5 and 5.6 above.

5.8.49 The cumulative effects assessment of non-Thames Tideway Tunnel project developments are:

a. under construction

b. permitted but not yet implemented

c. submitted but not yet determined.

5.8.50 Those considered as part of this assessment are those with likely significant effects on aquatic ecology receptors, and that are programmed to be under construction or operational at the same time as the Thames Tideway Tunnel project.

5.8.51 As for the site-specific assessments, effects have been considered qualitatively using professional judgement and have been reported according to whether they elevate or reduce the significance of an effect in comparison with the Thames Tideway Tunnel project on its own.

Assessment of effects on the proposed MCZ

5.8.52 Given that the proposed MCZ designation will be determined during 2013 it was considered appropriate to 'future proof' the project-wide assessment (Volume 3 Section 5) by determining how the designation of the MCZ would alter the significance of effects. The assessment elevates the value of the relevant receptors covered by the MCZ designation (smelt and eel) and the habitats they depend on to national status in accordance with Vol 2 Table 5.4.4. The new assessment has been undertaken based on the significance of effect matrix (Vol 2 Table 5.5.3). The assessment is reported in Vol. 3 Appendix 5.

5.9 Assumptions and limitations

5.9.1 This section details general assumptions and limitations associated with the aquatic ecology assessment. Site-specific assumptions and limitations are detailed in Vol 4-27 (aquatic ecology section).

5.9.2 Compared to the assessment at foreshore sites (eg, Chelsea Embankment Foreshore) which uses data collected at that particular site, the assessment of effects on non-foreshore project (eg, Earl Pumping Station) sites is based on data collected more remotely from the site and may therefore not reflect entirely accurately conditions (see Section 5.4). However, given that the tidal Thames is a continuous habitat the data and the assessment are considered to be sufficiently robust.

5.9.3 A number of the assessments are based on modelled information. The accuracy of the model outputs is a reflection of the input data and the degree to which the model is able to simulate real conditions. In all cases where models have been used the approach has been agreed with stakeholders.

5.9.4 Despite the above assumptions and limitations, the assessment is considered to be robust.

5.10 Mitigation

Construction

5.10.1 The Thames Tideway Tunnel project has been designed to minimise environmental effects and therefore the construction design/methods take account of aquatic ecology considerations including measures to control and minimise construction impacts such as waterborne noise and vibration, and water pollution (detailed within the *CoCP* Part A). Where such measures form part of the project, they are identified in Volume 1 Introduction to the Environmental Statement (for the tunnel) and Section 3 Proposed development of Vols 4-27 (for each site) and have been considered as embedded measures within the assessment.

5.10.2 Where the assessment indicates significant effects having taken account of embedded measures, mitigation has been identified as appropriate.

5.10.3 Where there has been no suitable land based alternative, foreshore sites have been selected with the aim of minimising the area of landtake from riverine habitats by locating as much of the construction infrastructure on land as possible. Where environmental design changes have already been made to the site or layout which reduces impacts on aquatic ecology receptors, this is described in Section 5 of the site assessment volumes (Vol 4 – 27).

5.10.4 In agreement with the Biodiversity Working Group, the assessment of aquatic ecology considers the losses from individual habitats associated with temporary and permanent landtake, and other area based impacts (such as compaction and dredging). Permanent losses have been used to inform the need for habitat compensation.

Operation

5.10.5 The Thames Tideway Tunnel project has been designed to minimise environmental effects and therefore the design takes account of aquatic ecology considerations including the need to minimise landtake from intertidal and subtidal habitats by locating sites on land where possible. Where such measures form part of the project, they are identified in Vol 1 (for the tunnel) and Section 3 Proposed development of Volumes 4-27 (for each site) and have been considered as embedded environmental design within the assessment.

5.10.6 Where the assessment indicates significant effects, having taken account of embedded environmental design, mitigation has been identified as appropriate. Where mitigation for a specific site is not always possible, this is acknowledged.

5.10.7 The operational effects of the project on aquatic ecology receptors would be beneficial to the tidal Thames. However, there would be permanent landtake at a site-specific and project-wide scale. The approach to compensation for habitat losses has been considered at a site-specific and project-wide level and has been guided by the Biodiversity Working Group. It takes into account both the losses from individual habitats, and the function of those habitats to the species they support. For example, the intertidal foreshore represents feeding and resting habitat, and a migratory pathway for freshwater and estuarine fish species. Compensation for the loss of this habitat may therefore include measures to enable access to suitable alternative habitats within tributaries and watercourses. This may include the removal or bypassing of weirs and structures.

5.10.8 A monitoring programme to measure the recovery of aquatic ecology receptors throughout the tidal Thames following interception of the CSO network would be implemented. Details of the monitoring programme, including the location of the potential monitoring sites, is reported in Vol 3.

5.11 Residual effects assessment

5.11.1 Where mitigation measures are proposed, residual effects are assessed qualitatively by considering the degree to which the impact has been ameliorated and using the matrix presented in Vol 2 Table 5.5.3 to assess significance.

5.11.2 Where no mitigation measures are proposed, the residual effects remain as identified through the relevant assessment (construction, operation or project-wide).

This page is intentionally blank

References

[1] Institute of Ecology and Environmental Management. *Guidelines for Ecological Impact Assessment in the United Kingdom* (2006).

[2] Thames Water Utilities Limited. *Lee Tunnel and Beckton STW extension. Environmental Statement* (2008).

[3] Thames Water Utilities Limited. *TTQI – Crossness STW. Environmental Statement* (2008).

[4] Environment Agency. *River Basin Management Plan, Thames River Basin District* (2009).

[5] Marine Conservation Zones: Consultation on proposals for designation in 2013 Department for Environment, Food and Rural Affairs http://www.defra.gov.uk/consult/2012/12/13/marine-conservation-zones-1212/ (last accessed December 2012)

[6] Department for Environment, Food and Rural Affairs. *Eel Management Plans for the United Kingdom: Thames River Basin District* (2010). Available at: www.defra.gov.uk. Accessed on 1 November 2012.

[7] HM Government. *Natural Environment White Paper 2011 - The Natural Choice: securing the value of nature*. HM Government (2011).

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

[9] Greenspace Information for Greater London (GiGL). Available at: www.gigl.org.uk.

[10] Colclough S R, Gray G, Bark A, & Knights B (2002) *Fish and fisheries of the tidal Thames: management of the modern resource, research aims and future pressures*. Journal of Fish Biology (2002), 61 (Supplement A), 64-73.

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

[12] Ratcliffe, D. *A Nature Conservation Review.* Volume 1. 402pp. Cambridge University Press, Cambridge, England. (1977).

[13] Thames Estuary Partnership Biodiversity Action Group. *Tidal Thames Habitat Action Plan* (2002).

[14] 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).

[15] Turnpenny, A.W.H. *et al*. See citation above.

This page is intentionally blank

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.02**

Volume 2: Environmental assessment methodology

Section 6: Ecology - terrestrial

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

Hard copy available in

Box **16** Folder **A**
January 2013

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

This page is intentionally blank

Thames Tideway Tunnel

Environmental Statement

Volume 2: Environmental assessment methodology

Section 6: Ecology – terrestrial

List of contents

Page number

List of tables

Page number

6 Ecology – terrestrial

6.1 Introduction

6.1.1 This section sets out the methodology for assessing the likely significant effects of the Thames Tideway Tunnel project on terrestrial ecology.

6.1.2 The methodology outlined in this section has been applied to all sites, apart from Victoria Embankment Foreshore, Blackfriars Bridge Foreshore and Bekesbourne Street which have been scoped out of the assessment for terrestrial ecology as no likely significant effects have been identified.

6.1.3 The need for an assessment of effects on terrestrial ecology results from the potential for the project to affect notable habitats and species due to:

a. disturbance from noise, vibration, lighting, the movement of people and construction vehicles and machinery

b. habitat changes due to site clearance and habitat creation.

6.1.4 Given the limited extent of permanent works, the infrequent maintenance requirements and no or limited operational lighting, there are not likely to be significant effects during operation on terrestrial ecology and therefore this is not assessed. On those sites where operational lighting is proposed, this would comply with Section 3 of the *Design Principles* (see Vol 1 Appendix B), which have been developed to minimise effects on terrestrial ecology.

6.1.5 There are not likely to be significant effects on terrestrial ecology beyond those assessed at a site level and therefore project-wide effects are not assessed. Screening under the *Conservation of Habitats and Species Regulations 2010* (*The Habitats Regulations 2010*) is reported separately in the *Habitat Regulations Assessment: No Significant Effects Report*.

6.1.6 The topic specific methodology presented in this section builds upon the general assessment methodology summarised in Section 3 of this volume and develops this to take account of the range of likely significant environmental effects on terrestrial ecology arising from the construction of the project.

6.1.7 The assessment includes all ecological receptors above mean high water level with the exception of wintering birds, which can forage on the foreshore below mean high water level. The methodology for the assessment of effects on aquatic ecology below mean high water level is provided in Section 5 Ecology – aquatic. The methodology for assessment of effects of construction dust on terrestrial ecology is provided in Section 4 Air quality. Construction dust would be adequately controlled through measures outlined in the *Code of Construction Practice (CoCP)* (Section 7) and therefore is not considered further in this assessment. The *CoCP* is provided in Vol 1 Appendix A. It contains general requirements (Part A), and site specific requirements (Part B).

6.1.8 The assessment of effects from deposition of nitrogen is also detailed in Section 4 Air quality.

6.2 Engagement

6.2.1 The general approach adopted regarding engagement is summarised in Section 2 of this volume. A description of the engagement undertaken for terrestrial ecology is described here along with a summary of comments made by stakeholders regarding the approach to the terrestrial ecology assessment. Site-specific aspects raised by stakeholders are included in the site assessments. Throughout the assessment process, there has been ongoing engagement with stakeholders on the development of the design and mitigation measures, which have been incorporated into the proposals, as detailed in each site assessment (Section 6, Vol 4 - 27). Prior to the issue of the *Scoping Report* a terrestrial ecology position paper on the scope of surveys was circulated to statutory consultees. The Environment Agency, London Borough Councils, Natural England and the London Biodiversity Partnership were consulted on the position paper.

6.2.2 The Environment Agency requested clarification within the *Scoping Report* on the method for assessing the need for further surveys of river walls for invertebrates and notable botanical species. This detail was provided in the *Scoping Report*.

6.2.3 The London Borough of Southwark queried whether the positioning of the remote recording devices for the bat surveys would record foraging and commuting along the Thames. The surveys included foraging and commuting records along the River Thames, where relevant to the site. Clarification was provided.

6.2.4 The London Borough of Tower Hamlets requested the use of the term notable species rather than protected species as the assessment must include all species of biodiversity interest. In response, the term notable species has been used throughout the assessment.

6.2.5 Westminster City Council requested more detailed surveys than the Phase 1 Habitat Survey undertaken along the foreshore of the River Thames. The Phase 1 Habitat Survey data has been used to inform the need for further surveys, including wintering birds, bat, botanical, and invertebrate surveys that are associated with this habitat. The London Borough also requested that we consult more widely, which we have done through the Biodiversity Technical Workshops (para. 6.2.9) and other meetings (para. 6.2.11).

6.2.6 No formal comments were received at this stage from the other London Boroughs, Natural England and The London Biodiversity Partnership.

6.2.7 A *Scoping Report* was issued in March 2011. Scoping opinions from this have informed the scope of surveys and the terrestrial ecology assessment. A summary of the scoping opinions and the terrestrial ecology responses are provided in Vol 2 Appendix D.1 Table D.2. The IPC also provided a response to the *Scoping Report*, focusing on the scope of the terrestrial ecology assessment and the types of effects to be assessed (see Vol 2 Appendix A.3), which have been addressed in this *Environmental Statement*.

6.2.8 Engagement has been undertaken with statutory and non-statutory bodies and interest groups as part of the assessment. This approach has been iterative and feedback from stakeholders has informed the scope of the desk study, surveys and assessment methodology, and the design, including embedded measures.

6.2.9 The following biodiversity technical workshops have been held to discuss the scope of the surveys and assessment, and proposals for avoiding, reducing, and compensating for significant adverse ecological effects:

a. 27 October 2010 – Biodiversity Technical Working Group meeting with the Environment Agency (EA). A discussion was held about the project proposals and associated likely effects on terrestrial and aquatic ecology.

b. 16 November 2010 – Biodiversity environmental impact assessment (EIA) scoping workshop with Natural England and representatives from the local planning authorities. A presentation was made on the overall approach to EIA scoping and the approach for terrestrial ecology. It was agreed that future workshops would include aquatic ecology and involve the EA and other interested stakeholders.

c. 22 March 2011 – Biodiversity Workshop with the EA, Thames21 and representatives from the local planning authorities. A presentation was given outlining the proposed scope of the desk study and the proposed survey methodologies. Stakeholders were asked to comment on the proposals and offer suggestions on possible additional sources of baseline data.

d. 26 July 2011 – Biodiversity and landscape technical working group meeting with the EA. The approach to mitigation for aquatic and terrestrial ecology and compensation for aquatic ecology was discussed, with input from the Thames Tideway Tunnel project landscape architects. The EA presented possible opportunities for mitigation and compensation schemes within the tidal River Thames.

e. 7 September 2011 – Biodiversity Workshop with the EA, Port of London Authority and representatives from the local planning authorities. Presentations were given to update stakeholders on ecological survey results, and progress with the embedded environmental design measures and proposals for mitigation for aquatic and terrestrial ecology and compensation for aquatic ecology. The scoping out of terrestrial ecology operational effects was also presented and agreed at the workshop.

f. 9 November 2011 – Biodiversity technical working group with the EA. Progress with identifying potential mitigation for both aquatic and terrestrial ecology and compensation schemes for aquatic ecology was discussed.

g. 29 February 2012 – Biodiversity technical working group with the EA. Presentation of baseline data and format of reporting for the *Environmental Statement*, the assessment methodology and progress with proposals for off-site compensation schemes (for aquatic ecology effects). Discussions in relation to phase two consultation responses.

h. 11 July 2012 – Biodiversity workshop with the EA, Natural England, London Wildlife Trust, Royal Society for the Protection of Birds (RSPB), the Marine Management Organisation (MMO) and representatives from local planning authorities. Presentations were made on survey results, juvenile fish modelling, invertebrate analysis, the approach to embedded design measures (including the *CoCP* and *Design Principles*) for both aquatic and terrestrial ecology and designing out adverse effects.

6.2.10 At the scoping stage, details of the nature and timing of operational activities were not defined. Therefore, a precautionary approach was taken to scope in operational effects at sensitive sites. Following a review of the maintenance regime for the operational phase, operational effects were not considered likely and therefore this phase has not been assessed (para. 6.1.4). This approach was presented at the Biodiversity Workshop 7 September 2011 (para. 6.2.9e).

6.2.11 In addition to biodiversity technical workshops, there were a series of meetings and discussions with stakeholders such as the Natural England, the RSPB and the All London Green Grid.

6.2.12 The methodology undertaken for surveying bats differs from standard guidance, as described in para. 6.4.14 to 6.4.23. Natural England and the local planning authorities were consulted on this approach (see Vol 2 Appendix D.1). The principles behind the approach to bat surveys were agreed with Natural England at a meeting held on 1 July 2011. The detailed methodology was then developed and issued as a memorandum to Natural England and the local planning authorities where bat surveys were required, and they were invited to comment. The results of the bat triggering surveys and dawn activity surveys were presented to stakeholders at the Biodiversity Workshop held on the 7 September 2011.

6.2.13 A meeting was held on 4 January 2012 with a representative of the All London Green Grid. This confirmed the opportunities created by the Thames Tideway Tunnel project to contribute towards this pan-London policy initiative to promote a network of green and open spaces across London.

6.2.14 A telephone conservation was held with the RSPB Conservation Officer on 10 January 2012 in which the general results of the wintering bird surveys were discussed and the relationship between birds at Beckton and the wider Thames Estuary. The RSPB Conservation Officer expressed their general support for the improvements that would result from the Thames Tideway Tunnel project.

6.2.15 Comments have been received from stakeholders as part of phase two consultation. Phase two consultation comments relevant to the terrestrial ecology methodology are provided in Vol 2 Appendix D.1 Table D.2.

6.2.16 There were no S48 consultation comments relating to the general methodology. Site specific comments relating to the methodology are provided in the site assessment volumes (Section 6, Vol 4 – 27).

6.3 Legislation and guidance

6.3.1 The scope of habitat and species surveys has been informed by the following legislation and policies:

a. Wildlife and Countryside Act (WCA), 1981 (as amended in 1985, 1991, 2000 [by the Countryside and Rights of Way Act] and 2004), which provides protection for wild birds, mammals, reptiles, invertebrates and plants. This legislation also prohibits planting in the wild or causing to grow certain invasive species listed in Schedule 9 of the Act. The Act also provides the mechanism for designating Sites of Special Scientific Interest (SSSIs).

b. The Conservation of Habitats and Species Regulations 2010 (The Habitats Regulations 2010), which provides protection for European Protected Species (eg, bats).

c. Countryside and Rights of Way (CRoW) Act, 2000, which strengthens protection for species listed in the Schedules of the WCA 1981 and for SSSIs.

d. Natural Environment and Rural Communities (NERC) Act, 2006, which puts an obligation on public authorities to have regard to the conservation of species and habitats of principal importance for the purpose of conserving biodiversity.

e. The *UK Biodiversity Action Plan* (*UK BAP*), which describes the UK's biological resources and commits to a detailed plan for the protection of these resources, focusing on key habitats and species considered to be of particular significance to nature conservation within a UK context (HMSO, 1994)[1]

f. London BAP, which details priority species and habitats for conservation action in Greater London.

g. London borough local BAPs (*LBAP*s), where these have been produced, which detail priority species and habitats for conservation action within each LB (LBP, 2011)[2].

h. Thames Water published a four-part company BAP in 1999 to protect and enhance biodiversity on Thames Water sites and during their operations.

6.3.2 The methodology for assessing the effects on terrestrial ecology has been informed by the following legislation and guidance:

a. *Guidelines for Ecological Impact Assessment in the United Kingdom. IEEM* (2006), commonly known as and referred to from here on as the *IEEM Guidelines*. Although these guidelines are currently under review, as this is ongoing, the current guidelines are applied. The *IEEM Guidelines* have been applied to the assessment methodology with additional terminology used in the valuation (Vol 2 Table 6.4.3) and assessment of significant effects (Vol 2 Table 6.5.1) in line with the project-wide approach to the assessment as described in Section 3 General EIA methodology.

b. There is a hierarchy of designated sites within the UK, as follows:

i Special Areas for Conservation (SAC) – European statutory designated sites protected for habitats, plants and animals under the Conservation of Habitats and Species Regulations 2010 (McLeod, CR, *et al,* 2012)[3].

ii Special Protection Areas (SPA) – European statutory designated sites for birds under The Conservation of Habitats and Species Regulations 2010 (JNCC, 2012)[4].

iii Sites of Special Scientific Interest (SSSI) – National statutory designated sites protected under the Wildlife and Countryside Act 1981 and the CROW Act 2000 (JNCC, 1989)[5].

iv National Nature Reserves (NNRs) – a selection of the best SSSIs chosen by the statutory authority (Natural England) and often having other designations such as SAC or SPA.

v Local Nature Reserves (LNRs) – Statutory designated sites that are the best examples within a district or county (referred to as borough or metropolitan area respectively within a London setting and within this assessment hereafter). They are designated under Section 21 of the National Parks and Access to the Countryside Act 1949, and amended by Schedule 11 of the Natural Environment and Rural Communities Act 2006 (Natural England, 2010)[6].

vi Sites of Importance for Nature Conservation (SINCs or Local Sites) – non-statutory designated sites implemented by the local authority and given material consideration in the planning process (The London Wildlife Site Board, 2011)[7]. Whilst these are called Local Sites, they range from local to metropolitan designated sites. In London, SINCs are subdivided into the following categories:

- SINC (Grade L), which is a site of local importance
- SINC (Grade B), which is a site of borough importance
- SINC (Grade M), which is a site of metropolitan importance.

6.3.3 The criteria on which these designations are based have been used to inform the valuation criteria for ecological receptors. For example, a site that is not currently designated as a nature conservation site is evaluated against the corresponding criteria for designated sites and valued accordingly. Similarly, the same criteria are applied to the evaluation of designated sites to confirm their current status.

6.3.4 A mitigation strategy has been developed to enable significant adverse effects of the project on terrestrial ecology to be avoided, reduced, mitigated and/or compensated for, as described in Section 6.10. In developing this strategy, consideration has been given to the following policies, in addition to the legislation and guidance outlined above:

a. *Natural Environment White Paper 2011*, which sets out measures to protect and improve the health of ecosystems, the need to acknowledge that nature works as a system, which has a variety of functions and benefits (ecosystem services), and highlights the importance and values of coherent ecological networks and the need to take a landscape scale approach. Introduces the concept of 'biodiversity offsets' which are 'conservation activities designed to deliver biodiversity benefits in compensation for losses in a measurable way'. The purpose of biodiversity offsets is to ensure that developments result in no loss of biodiversity overall (HM Government, 2011)[8].

b. The National Planning Policy Framework states that 'the planning system should contribute to and enhance the natural and local environment by minimising impacts on biodiversity and providing net gains in biodiversity where possible, contributing to the Government's commitment to halt the overall decline in biodiversity, including by establishing coherent ecological networks that are more resilient to current and future pressures' (Department for Communities and Local Government, 2012)[9].

c. A range of local and regional planning policies are relevant to terrestrial ecology. The majority of local policies seek the following as part of development proposals:

i Measures to avoid, mitigate or compensate for scheme effects on local non-statutory site designations and species of local interest.

ii Biodiversity enhancements such as green and brown roofs, and enhancements that contribute towards local biodiversity action plan targets.

iii Protection measures for mature trees and sensitive habitats.

6.3.5 Vol 2 Table 6.3.1 presents the requirements within the NPS relevant to terrestrial ecology and explains how the requirements have been addressed within the ES. The table also gives the location of the relevant material.

Vol 2 Table 6.3.1 Terrestrial ecology – requirements of the NPS and how they have been addressed

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
The applicant should ensure the ES clearly sets out any effects on internationally, nationally and locally designated sites of ecological or geological conservation importance, on protected species, and on habitats and other species	The ES describes for each site the significant ecological receptors including statutory and non-statutory designated sites, habitats, and protected and notable species that could be affected by the proposed development. The ES then assesses the likely effects on these and mitigation has been proposed where significant adverse effects have been identified.	Full details of the terrestrial ecology baseline and assessment of likely significant effects are provided in the site assessments (Volumes 4 to 25).

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
identified as being of principal importance for the conservation of biodiversity.		
The applicant should demonstrate that habitats will, where practicable, be restored after construction works have finished. The applicant should show how the project has taken advantage of opportunities to conserve and enhance biodiversity and geological conservation interests. The applicant should demonstrate that opportunities will be taken to enhance existing habitats and, where practicable, to create new habitats of value within the site landscaping proposals.	A mitigation strategy has been implemented during the design stage of the project to avoid impacts wherever practicable. Where impacts are unavoidable, measures to minimise the effect such as the reduction in the loss of mature trees and the incorporation of the measures outlined in the Section 11 of *CoCP* Part A and B would be undertaken. Habitat replacement forms part of the design for assessment including replacement of significant habitat lost where possible with an area of similar size, or if reduced in size, an area of higher value habitat. For example, species-poor amenity grassland could be replaced by species-rich meadow. The *Design Principles* (Section 3) also seek to provide a net increase in trees over the project and replacement of those trees removed. The overall aim has been to provide no overall loss in biodiversity value across the sites. Brown roofs, bird nesting boxes, bat roosting boxes and invertebrate boxes have been included in the design at several sites. In addition, the landscape proposals have included the provision of trees, scrub and species-rich grassland at several sites.	The mitigation strategy can be found in Vol 2 Section 6.10. The description of amendments made during the design process is provided in Vol 1. Measures to avoid and minimise impacts during construction can be found in the Section 11 of CoCP Part A and B. The proposals for replacement habitats and the provision of enhancement features can be found on the landscape plans and within the *Design Principles* (Section 3). An assessment of the significance of the effects with embedded measures and with relevant mitigation measures (where significant adverse effects have been identified) can be found in the site assessments (Vol 4 to 27).
The applicant should demonstrate that during construction, they will seek to ensure that activities will be confined to the	The boundaries of the maximum working areas for construction have been set out in the construction plans. This has included adjustments to minimise tree loss and the loss of intertidal foreshore.	Site assessment volumes (Vol 4 to 25)

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
minimum areas required for the works.		
The applicant should demonstrate that during construction and operation, best practice will be followed to ensure that risk of disturbance or damage to species or habitats is minimised, including as a consequence of transport access arrangements.	The *Code of Construction Practice* sets out the best practice and project specific measures to be implemented during the construction phase to ensure that the risk of disturbance or damage to species or habitats is minimised. Within Section 11 of Part A of the *CoCP* there is a requirement for the contractor to produce a Ecology and Landscape Management Plan for each site, demonstrating how each of the measures set out in the *CoCP* will be implemented on site during construction. The operation phase was scoped out of the assessment, as no likely significant effects were identified for the operational phase.	*Code of Construction Practice* Part A Section 11.

6.4 Baseline data collection

6.4.1 The baseline data has been obtained from desk based sources, a Phase 1 Habitat Survey and, where necessary, subsequent surveys for notable species.

Desk based baseline data

6.4.2 Information on ecological resources has been obtained from a range of sources. The data sources have included the following:

a. Aerial photographs

b. Data search from Greenspace Information for Greater London (GiGL), which acts as a central source for collated biological records, information from London’s local authorities, statutory and non-statutory agencies, non-governmental organisations, private companies and individuals.

c. Existing survey reports and publications, where available.

d. Internet based data sources.

e. Thames Estuary Partnership (2002) *Tidal Thames Habitat Action Plan*.

f. *London Biodiversity Action Plan* and borough *Biodiversity Action Plans*.

g. Information from stakeholders such as the Wildfowl and Wetlands Trust (WWT).

6.4.3 A full list of data sources is provided in Vol 2 Appendix D.3. The desk based data has been used to:

a. identify sensitive ecological receptors on or near to the site

b. inform survey areas

c. value ecological receptors

d. support the findings of site surveys

e. inform mitigation and enhancement measures for the proposed development.

Field survey baseline data

6.4.4 A Phase 1 Habitat Survey and notable species surveys have been undertaken, and the survey methodologies are described below.

Phase 1 Habitat Survey

6.4.5 Phase 1 Habitat Surveys have been undertaken at all sites by experienced ecologists in accordance with JNCC survey guidelines (JNCC, 2010)[10]. The survey area included all habitats within the site boundary and adjacent habitats that could be affected by the works eg, trees with their roots extending across the site boundary. The timing of surveys is given in the site assessment volumes (Vol 4 - 27).

6.4.6 The surveys comprised a walkover of the sites to record notable habitat types, evidence of notable species and the potential for notable species. This data was used in combination with the desk study to identify the need for further more detailed botanical and notable species surveys. The sites at which further surveys were undertaken, and the survey details are shown in Vol 2 Table 6.4.1.

Otter (*Lutra lutra*) and water vole (*Arvicola aquatica*) survey

6.4.7 Surveys for otter and water vole have been undertaken along watercourses within and adjacent to two sites, namely Barn Elms in October 2011 and Abbey Mills Pumping Station in September 2011. The survey method followed the New Rivers and Wildlife Handbook (D Ward, N, *et al,* 1994)[11] and the Water Vole Conservation Handbook (Strachan R, 1998)[12]. Otter and water vole surveys can be carried at any time of year, although the period from March to October is the optimal survey period for water vole, and surveys for both otter and water vole should not be undertaken during or immediate after periods of heavy rain, or in very cold conditions. The surveys were undertaken in accordance with these survey timings and conditions.

6.4.8 At Barn Elms, the Beverley Brook adjacent to the south of the site was considered to have potential for these species. At Abbey Mills Pumping Station, the banks along the Channelsea River and Abbey Creek adjacent to the site to the south were considered to have potential for otter and water vole.

6.4.9 The surveys involved two surveyors searching the suitable bank habitat and in-channel features such as logs/large stones protruding above the water's surface (where accessible) for signs of the presence of otter and water vole such as otter spraint, otter holts, water vole latrines, runs, burrows and feeding remains.

6.4.10 Details of the otter and water vole surveys including survey results are provided in the site assessment volumes (Sections 6 in Vol 6 and 25 for Barn Elms and Abbey Mills respectively).

Badger (*Meles meles*) survey

6.4.11 Badger surveys have been undertaken at one site: Barn Elms. The surveys followed the Mammal Society methodology (Harris S, *et al,* 1989)[13]. The surveys were undertaken in March and September 2011, which are appropriate times of year to undertake badger surveys. Surveys can be limited by periods of heavy rain or snow, which can wash away evidence of badgers. Therefore, the surveys were undertaken at a time when the badger survey would not be limited by these conditions. The survey area included the site, the playing fields adjacent to the site and connecting areas of vegetation. Two visits were undertaken to search for signs of badger presence, including setts, established foraging paths, footprints, hairs and dung pits/latrines within areas of suitable habitat such as grassland, patches of scrub, woodland and along the bases of hedgerows.

6.4.12 All signs of badgers that were found have been mapped in order to establish patterns of activity within the survey area. As no badger sett locations were identified during these surveys, further detailed badger surveys were not considered necessary.

6.4.13 Details of the badger survey, including survey results, are provided in the site assessment volume for Barn Elms (Section 6 of Vol 6).

Bat surveys

6.4.14 General survey principles are based on the Bat Conservation Trust's Good Practice Guidelines (BCT, 2007)[14] and the Bat Workers Manual (BCT, 2004)[15]. In consultation with Natural England and the local planning authorities, the standard survey methodologies have been adapted to allow for survey effort to be directed towards features of most likely value to bats.

6.4.15 The surveys involved the initial identification of potential for bats to be foraging, commuting or roosting on or in close proximity to the site. Where potential bat habitat was identified, a further survey was undertaken using remote recording equipment. The results of these surveys were then used to identify if a dawn survey was required. The methodology is described in full below.

Identification of potential for bats

6.4.16 During the Phase 1 Habitat Survey walkover, features that could support roosting and/or foraging and commuting bats were identified and recorded including the following:

a. Habitats such as trees, scrub, grassland and watercourses that may support invertebrates that could provide a foraging resource for bats.

b. Linear habitat features such as watercourses, and tree and scrub lines that could provide a commuting route for bats.

c. Holes, cracks, fissures and peeling bark on trees that could provide potential roosting opportunities for bats.

d. Buildings with loose tiles, missing bricks and any other potential access points that could provide potential roosting opportunities for bats.

6.4.17 Where any of these features for bats were identified, further bat surveys were undertaken as described in para. 6.4.18 to 6.4.23 at the sites listed in Vol 2 Table 6.4.1.

Bat triggering (remote recording) surveys

6.4.18 Remote recording surveys for bats were undertaken at sites where potential for bats was identified to determine whether more detailed surveys were required, ie, to trigger further surveys. Remote recording bat detectors (Anabats™) were installed at those sites identified as having potential for bats. The detectors record the echolocation calls and times of bats passing the detector. The bat detectors were secured at appropriate locations based on the results of the Phase 1 Habitat Survey. These locations were selected to determine the usage of the site and immediate surrounds by bats. The bat detectors were left in place to record for three consecutive nights during the active bat season (May to October). The weather forecast was checked in advance of installing the bat detectors to ensure that the survey conditions were suitable (not in heavy rain, strong wind or cold weather). At some sites, actual weather conditions were not as forecast. Where this has affected the survey results at some sites, this is reported in the site assessment and appendix for that site.

6.4.19 The bat echolocation calls were analysed using computer software (Analook™) to determine the number of species and passes of bats, and the time that each of these passes were recorded. Further dawn surveys were triggered where the data indicated that one of the following criteria had been met:

a. a roost is suspected on or near the site (registrations occur within 30 minutes of sunset and/or 1 hour of sunrise)

b. a considerable level of bat activity was recorded (a maximum number of bat registrations (or bat passes) recorded in any one night at any one Anabat location that is greater than 50)

c. a bat species other than common pipistrelle *(Pipistrellus pipistrellus)* and soprano pipistrelle *(Pipistrellus pigmaeus)*, which are by far the most abundant species in the region, were recorded.

6.4.20 As there is no standard guidance on specifically what might constitute considerable bat activity, the threshold for bat activity was determined using a combination of professional judgement and the median of the highest number of bat registrations recorded in one night at any site. The relative levels of activity between the sites were reviewed, and knowledge of the number of bat passes generally recorded during surveys of other sites was used in defining this threshold. The median has been used rather than the mean because the mean number of bat passes of 143 registrations across all sites has been skewed by the very high numbers of registrations at Barn Elms, and high numbers at other sites including Kirtling Street, Greenwich Pumping Station and Chelsea Embankment. In contrast, the median value across the maximum counts at all sites of 64 registrations appears to be closer to an appropriate threshold level. Therefore, given the median value of 64 registrations and applying professional judgement, a conservative threshold of 50 registrations within a night was applied. Where this threshold was exceeded, activity (dawn) surveys were undertaken.

Activity (dawn) survey

6.4.21 Where the need for further survey was identified during analysis of remote recording survey data, a dawn survey was undertaken during the active bat season of May to October inclusive. The surveys were carried out between June and October 2011. The surveys were undertaken in suitable weather (not in heavy rain, strong wind or cold weather) wherever practicable. The weather conditions for each survey visit were recorded.

6.4.22 The survey involved surveyors walking through the survey area during the two hours preceding dawn, observing and recording bat activity using hand-held bat detectors. The survey focused on potential foraging, commuting and roosting features on and adjacent to the site that were identified during the Phase 1 Habitat Survey (para. 6.4.16). The time and general direction of each bat pass was recorded and the activity was mapped. The time of sunrise was also recorded. Bats tend to return to their roosts within the hour preceding dawn. Therefore, the times of the bat passes in relation to sunrise and the direction of flight can be used to identify the location of potential bat roosts.

6.4.23 The bat survey results are given in the relevant site assessment volumes (Section 6 in Vol 4 - 27).

Bird surveys

Breeding bird survey

6.4.24 Breeding bird surveys were undertaken at sites where breeding bird potential had been identified (listed in Vol 2 Table 6.4.1) and followed standard survey guidance provided by the British Trust for Ornithology (Marchant J H, 1983)[16]. The survey area included potentially suitable features on site and in close proximity to the site that are considered (using professional judgement) to be potentially affected by the project. Three visits were carried out within the optimal survey period of March to June 2011 as follows:

a. March and April (to set up route/count positions and record habitat)

b. Early April to mid-May (early transect and count)

c. Mid-May to late June (late transect and count).

6.4.25 The latter two visits were carried out at least four weeks apart. All surveys were undertaken in suitable weather conditions (not in strong wind and/or rain that would reduce bird activity). The weather conditions were recorded for each survey visit. The locations of the breeding territories observed during the surveys were mapped including the species name and their conservation status. Any other observations, such as foraging activity of a non-breeding species, were also noted.

6.4.26 Details of the breeding bird surveys and survey results are provided in the relevant site assessment volumes (Section 6 in Vol 4 - 27).

Wintering bird survey

6.4.27 Initial wintering bird survey visits were undertaken at sites (listed in Vol 2 Table 6.4.1) where potential for wintering birds was identified during the Phase 1 Habitat Survey, such as the presence of water, areas of foreshore potentially used for foraging and resting, and shelter for high tide roosts. The survey followed RSPB methodology guidance[17] (Gilbert *et al.*, 1998)[18].

6.4.28 No notable wintering bird activity was recorded during the initial bird survey visit at Acton Storm Tanks and King George’s Park and no further surveys were undertaken at these sites. Therefore, wintering birds are not included in the site-specific assessments for these sites. Full wintering bird surveys were undertaken at the remaining 15 sites where wintering bird activity was recorded during the initial survey visit.

6.4.29 The survey area selected for each site varied between sites depending on the association between the activity recorded on site and activity within adjacent habitat. The survey areas are described in Appendix D of the relevant site assessment volumes (Vol 4 – 27).

6.4.30 Six survey visits were undertaken at monthly intervals within the optimal survey period of October to March, up to four hours after sunrise or four hours before sunset. These included dedicated waterbird surveys also undertaken to record the presence and numbers of waterbird species one hour either side of low tide. Counts were undertaken from fixed vantage points using a telescope and/or binoculars. The usage of habitat on and adjacent to the site was noted such as areas used for foraging, resting and shelter by wintering birds. Wintering bird surveys can be limited by heavy rain and high wind. Therefore, surveys were undertaken during dry weather with limited wind wherever practicable.

6.4.31 Details of the wintering bird surveys and survey results are provided in the relevant site assessment volumes (Section 6 in Vol 4 - 27).

Black redstart *(Phoenicurus ochruros)* survey

6.4.32 Black redstart surveys have been undertaken at sites where black redstart potential was identified by experienced ornithologists in line with RSPB guidance (Gilbert G, *et al,* 1998)[19]. The sites are listed in Vol 2 Table 6.4.1. The survey area included both potentially suitable nesting features on site such as buildings and structures, and foraging habitat such as sparsely vegetated open areas on or in close proximity to the site that are considered (using professional judgement) to be potentially affected by the project.

6.4.33 Five fortnightly visits were undertaken at the sites (listed in Vol 2 Table 6.4.1) from April to July. The survey visits were undertaken in suitable weather conditions such as no or low rainfall and/or wind at the time of survey. Weather conditions were recorded for each survey visit. The surveys were undertaken for a minimum of three hours during the early morning period and/or evening hours.

6.4.34 The survey method involved walking at a constant pace across the site along a transect, and observing and recording the presence/absence of black redstarts in the survey area, and any indications of territorial and nesting behaviour, as well as identifying the locations and numbers of any nests present on or near the site.

6.4.35 The black redstart survey results are given in the relevant site assessment volumes (Section 6 in Vol 4 - 27).

Reptile survey

6.4.36 Reptile surveys were undertaken at Acton Storm Tanks, Barn Elms, Abbey Mills Pumping Station and Beckton Sewage Treatment Works, where there are historic records of reptiles and/or potential habitat was identified during the Phase 1 Habitat Survey such as a mosaic of grassland, scrub and tall ruderal vegetation, and shelter. The reptile survey methodology has followed the guidance by Froglife (Froglife, 1999)[20] and the Joint Nature Conservation Committee (JNCC) (Gent T and Gibson S, 2004)[21].

6.4.37 The aim of the surveys has been to ascertain presence or likely absence of reptiles on and adjacent to the site. Refugia (sheets of roofing felt approximately 0.75m by 0.75m) were laid at a minimum density of ten sheets per hectare, within suitable habitat. Refugia were checked twice a day over a non-consecutive period of ten days divided across the optimal survey period of April, May and September 2011, avoiding the hot summer months when reptiles are less likely to use artificial refugia. Surveys were undertaken in suitable weather conditions, between 9°C and 18°C without heavy rain and/or high winds. The weather conditions were recorded for each survey visit.

6.4.38 Details of the reptile surveys and survey results are provided in the relevant site assessment volumes (Section 6 in Vol 4 - 27).

Great crested newt *(Triturus cristatus)* assessment

6.4.39 A habitat suitability assessment of waterbodies for great crested newt was undertaken at Barn Elms, King George's Park, and King Edward Memorial Park Foreshore because waterbodies were present in close proximity to the sites. This type of assessment can be undertaken at any time of year and would only be limited by extreme weather conditions that would reduce visibility or ground coverage such as heavy snow. None of the other sites are connected by terrestrial habitat with any waterbodies in the vicinity of the site or have waterbodies present on site. The Habitat Suitability Index scoring system (Oldham RS et *al*, 2000[22]) was used to score the waterbodies. The waterbody is scored as poor, below average,

average, good or excellent based on the following factors that influence the suitability of the waterbody for breeding:

a. the geographic location of the waterbody

b. the surface area of the waterbody when the water is at its highest level

c. the frequency with which the waterbody dries out

d. water quality

e. shade

f. the presence of waterfowl

g. the presence of fish

h. the number of waterbodies in the area

i. the quality of terrestrial habitat surrounding the waterbody

j. the surface area of the waterbody covered by macrophytes (aquatic, submerged and emergent plants).

6.4.40 The assessment score was considered alongside existing species records for the area and the suitability of connecting habitat between the site and the waterbody to determine whether further surveys were required. As no waterbodies were considered to have higher than a low average potential for great crested newts to be present, no further surveys were undertaken.

6.4.41 The results of the habitat suitability index assessment are provided in the relevant site assessment volumes (Section 6 in Vol 6, 9 and 21 for Barn Elms, King George's Park and King Edward Memorial Park Foreshore respectively).

Invertebrate survey

6.4.42 Invertebrate surveys were undertaken at four sites namely Barn Elms, Dormay Street and Cremorne Wharf Depot (river wall and jetty only), which were identified during the Phase 1 Habitat Survey as having habitat that could support notable invertebrate species or assemblages. These habitats included grassland, scrub and trees, dead wood, unmanaged brownfield land and river walls. Surveys were initially undertaken at Abbey Mills. However, the site conditions changed as a result of consented Lee Tunnel Works during the period of survey so that the site no longer contained habitat that could support notable invertebrate species. Semi-improved grassland was also removed at Greenwich Pumping Station following the Phase 1 Habitat Survey and the site was not considered to be suitable for notable assemblage of invertebrates following this habitat clearance. Consequently, invertebrate survey results are not reported in the site assessment volumes for these sites.

6.4.43 The surveys have followed Natural England guidelines (English Nature, 2005)[23] with the survey methodology informed by professional judgement. Surveys were undertaken between May and September 2011 in suitable weather conditions (dry and calm conditions).

6.4.44 An initial survey visit was undertaken to identify specific habitat types that were considered to require more detailed invertebrate survey and sampling. As no notable invertebrates were recorded during the initial survey visit at Cremorne Wharf Depot and Dormay Street, no further survey visits were undertaken. Three further visits were undertaken at Barn Elms because notable species were found during the initial visit.

6.4.45 Invertebrate sampling comprised sweep netting and scrub beating. Sweep netting involves the use of a butterfly net to capture invertebrates. Scrub beating with a net allows invertebrates dislodged from vegetation to be caught and examined. Captured invertebrates were taken from site for identification where these could not be identified on site. The combined results of the multiple visits is used to build up a picture of the size and diversity of invertebrate assemblages present on the sites. The surveys were undertaken in suitable weather conditions (no rain or high winds).

6.4.46 Details of the invertebrate surveys including survey results are provided in the relevant site assessment volumes (Section 6 in Vol 4 - 27).

Botanical survey

6.4.47 A botanical survey was undertaken on river wall and jetty habitats at Cremorne Wharf Depot, as the river wall and jetty were identified during the Phase 1 Habitat Survey as having potential to support notable botanical species. The botanical survey methodology is adapted from the National Vegetation Classification survey methodology (Rodwell JS, 2000)[24]. Five 2m x 2m quadrats, representative of river wall habitat were sampled by botanists. This type of survey can be undertaken during the main growing season of May to October. This survey would only be limited by extreme weather conditions that would limit visibility.

6.4.48 The results of the botanical survey at Cremorne Wharf Depot are provided in Section 6 in Vol 12.

6.4.49 A botanical survey was scheduled to be undertaken at Abbey Mills Pumping Station following the Phase 1 Habitat Survey, as the sparsely vegetated habitat on site was considered to have potential for notable botanical species. However, the site was cleared of vegetation as part of the consented Lee Tunnel works after the Phase 1 Habitat Survey was undertaken. No habitats with potential to support notable species of flora were then present on or immediately adjacent to the proposed development site. Therefore, a botanical survey has not been undertaken at this site.

Invasive plant survey

6.4.50 Invasive plant surveys were undertaken at sites (listed in Vol 2 Table 6.4.1) in between May and October (during the main growing season) where either the invasive plants were present (as identified during the Phase 1 Habitat Survey), the site was identified as having potential for them (eg, industrial site with excavated material heaps) or areas of the site were not fully accessed during the Phase 1 Habitat Survey as invasive were considered likely to be present. This survey would only be limited by extreme weather conditions that would limit visibility, which did not occur. Invasive plants are categorised as all those listed as ‘injurious’ on Schedule 9 of the WCA 1981.

6.4.51 The survey area included the site and areas within 10m of the site boundary. The 10m survey buffer surrounding the site is considered appropriate in order to record invasive plants in close proximity to the site that may colonise the site in the near future, and to identify plants that could have roots or rhizomes (underground growth) extending into the proposed development site (eg, Japanese knotweed (Fallopia japonica)). The locations and extents of invasive plants were mapped to inform later remediation plans. The results of the invasive plant surveys are provided in the relevant site assessment volumes (Section 6 in Vol 4 - 27). The methodology for the assessment of likely significant effects on the built environment from the presence of invasive species is described in Section 8 Land Quality in this volume.

Vol 2 Table 6.4.1 Terrestrial ecology – notable species surveys by site

Site	Badger	Bats	Black Redstart	Botanical	Breeding Birds	Invasive Plants	Inverte-brates	Otter	Reptiles	Water Vole	Wintering Birds
Acton Storm Tanks		✓							✓		✓
Hammersmith Pumping Station		✓									
Barn Elms	✓	✓			✓	✓	✓	✓	✓	✓	✓
Putney Embankment Foreshore		✓									✓
Dormay Street		✓	✓		✓	✓	✓				✓
King George's Park		✓									✓
Carnwath Road Riverside		✓	✓			✓					✓
Falconbrook Pumping Station		✓				✓					
Cremorne Wharf Depot		✓	✓	✓ (river wall and jetty only)		✓	✓ (river wall only)				✓
Chelsea Embankment Foreshore		✓				✓					✓
Kirtling Street		✓	✓			✓					✓
Heathwall Pumping Station		✓	✓								✓

Site	Badger	Bats	Black Redstart	Botanical	Breeding Birds	Invasive Plants	Inverte -brates	Otter	Reptiles	Water Vole	Wintering Birds
Albert Embankment Foreshore		✓									✓
Shad Thames Pumping Station		✓	✓			✓					
Chambers Wharf		✓	✓			✓					✓
King Edward VII Memorial Park Foreshore		✓				✓					✓
Earl Pumping Station						✓					
Deptford Church Street		✓									
Greenwich Pumping Station		✓	✓		✓	✓					✓
Abbey Mills Pumping Station		✓	✓		✓	✓	✓	✓	✓	✓	✓
Beckton Sewage Treatment Works		✓	✓		✓	✓			✓		✓

Receptor identification and sensitivity

6.4.52 The ecological receptors are valued using a geographical scale in line with the *IEEM Guidelines* (IEEM, 2006)[25]. To allow for project-wide compatibility, the IEEM terminology has been adapted to align as far as possible with the project terminology (Vol 2 Section 3.7). The relationship between the IEEM terminology and the project terminology is given in Vol 2 Table 6.4.2.

Vol 2 Table 6.4.2 Terrestrial ecology – the relationship between ecological receptor values based on IEEM terminology and the project terminology

Ecological receptor value based on IEEM	Ecological receptor value based on project terminology
International	High
National	High
Regional (South East UK)	High
Metropolitan (Greater London)	Medium - high
Borough	Medium
Local (Town)	Low – medium
Site	Low
No significant resource*	Negligible

** Note the term significant resource is associated with the IEEM guidelines, meaning the resource is valued at a particular geographic scale. Note this is not the same as a significant effect which is defined in Vol 2 Table 6.5.1 below.*

6.4.53 The value of each ecological receptor has been determined by considering the following factors based on the *IEEM Guidelines*:

a. Statutory and non-statutory site designations based on those in para. 6.3.2b.

b. Biodiversity value:

 i Protected species status (European Protected Species, species listed in the WCA etc.).

 ii *Biodiversity Action Plan* status (Priority Habitat or Species included within borough, Greater London and/or UK BAPs).

 iii Population status of birds in the UK (red, amber and green list species) (Eaton MA, et al, 2009)[26].

 iv *British Red Data Books* status (specific books are referenced in the relevant assessment volumes [Section 6 in Vol 4 - 27]).

 v National/metropolitan flora status.

c. Potential value, such as a site that would increase in value if managed in a certain way.

d. Secondary and supporting value, such as a non-designated site that supports protected species.

e. Social value (those sites that, irrespective of biodiversity value, contribute to ecological conservation, eg, through environmental education).

6.4.54 A table detailing the criteria for valuing ecological receptors is provided in Vol 2 Table 6.4.3.

Vol 2 Table 6.4.3 Terrestrial ecology – valuing ecological resources (adapted from the IEEM Guidelines)

Value (IEEM value in brackets)	Ecological features
High (International)	A habitat or species cited as a reason for the designation or proposed designation of a World Heritage Site, Biosphere Reserve, Biogenetic Reserve, Ramsar Site, Special Protection Area (SPA) or Special Area of Conservation (SAC). A large extent of habitat that is listed as a Priority Habitat Type in Annex 1 of the *EC Habitats Directive* in good condition with typical species diversity. A large and viable population of a regularly occurring species that is rare within an international context. A site that regularly supports >1% of the European population of a species listed in Annex I of the *Birds Directive* (79/409/EEC as amended) in any season. A site that regularly supports >20,000 waterbirds (as defined by the Ramsar Convention) in any season. A roost and associated habitat of lesser horseshoe bat (*Rhinolophus hipposideros),* greater horseshoe bat (*Rhinolophus ferrumequinum*), barbastelle bat (*Barbastella barbastellus)* or Bechstein's bat (*Myotis bechsteinii*)
High (National)	A habitat or species cited as a reason for the designation or proposed designation of a National Nature Reserve (NNR) and Site of Special Scientific Interest (SSSI). Any area of habitat listed as a Priority Habitat Type in Annex 1 of the *EC Habitats Directive* that has potential to support typical species diversity (that would not qualify for designation at international level). A large extent of habitat listed as a Priority Habitat in the UK BAP in good condition that supports an abundance of typical species. A large and viable population of a regularly occurring species that is scarce within an international context. A very large and viable population of a regularly occurring species that is listed as a Priority Species in the UK BAP. A large and viable population of a regularly occurring rare species that occurs in 15 or fewer 10km squares of the National Grid (eg, a species that is listed in UK Red Data Books). A site that regularly supports >1% of the British population of a species listed in Annex I of the *Birds Directive* (79/409/EEC as amended) in any season.

Value (IEEM value in brackets)	Ecological features
	A site that is used by a native species with a British population of <1,500 breeding pairs (Holliday M & Rare Breeding Bird Panel, 2011)[27]. A roost that would qualify for designation as a SSSI (exceptionally large colonies with a long history of usage of a particular site for uncommon species such as Natterer's [Myotis nattereri], Daubenton's [Myotis daubentonii], whiskered [Myotis mystacinus], Brandt's [Myotis brandtii], serotine [Eptesicus serotinus], noctule [Nyctalus nyctalus], Leisler's [Nyctalus leisleri] and brown long-eared [Plecotus auritus]). Large hibernation roosts of these species).
High (Regional)	A large extent of habitat listed as a Priority Habitat in the UK BAP that supports typical species diversity and is in good condition. A large and viable population of a regularly occurring species that is listed as a Priority Species in the UK BAP. A large and viable population of a regularly occurring plant species that is known to occur in 16 to 100 10km squares of National Grid (Stewart A, et al, 2004)[28]. A large and viable population of a regularly occurring insect species (Nationally Notable categories Na and Nb) that is known to occur in 16 to 100 10km squares of the National Grid. A site that regularly supports >1% of the South East England population of a bird species of nature conservation importance (because the species is included in Red Data Birds in Britain (Batten LA, et al, 1990)[29], Birds of Conservation Concern (Royal Society for the Protection Birds, 2009)[30] Red or Amber List and/or on the UK BAP (United Kingdom Biodiversity Action Plan Steering Group, 2011)[31] Priority List) in any season. Any bat roost or hibernation site of the species list under 'national value' where exceptional numbers have not been recorded.
Medium-high (Metropolitan)	A nature reserve designated at any other level that no longer meets the criteria for their designation, but meets the criteria for designation as a SINC (Grade M)[i].

[i] SINC (Grade M) = Site of Nature Conservation Importance (Grade III of Metropolitan importance). These are sites that provide significant contributions to the ecology of the London Metropolitan area. Selection is based on the availability of similar habitat within this area and the geographic relationship with nearby wildlife sites. This includes good

Value (IEEM value in brackets)	Ecological features
	A Local Nature Reserve (LNR) designated as one of the best examples of habitats and/or species assemblages in the Metropolitan area. Habitats and/or species cited as the reason for or that would meet the criteria for Local Wildlife Site designation as a SINC (Grade M). A medium and viable population of a regularly occurring species that is listed as a Priority Species in the UK BAP. A viable population of a regularly occurring species listed in a County Red Data Book, County Flora or found in less than 10% of 1km squares of the National Grid within the count. A breeding or mating roost, or hibernacula of the common pipistrelle and/or soprano pipistrelle bats supporting exceptional numbers of bats and directly associated foraging habitat. A site that regularly supports ≥10% of the Greater London population (of a species listed in Red Data Birds in Britain, Birds of Conservation Concern Red or Amber List and/or on the *UK Biodiversity Action Plan* [UK BAP] Priority List) in any season. Small numbers of bats species listed under 'National value'.
Medium (Borough)	A nature reserve designated at any other level that no longer meets the criteria for their designation, but meets the criteria for designation as a SINC (Grade B[ii]). A Local Nature Reserve (LNR) designated as one of the best examples of habitats and/or species assemblages in the Borough. Habitats and/or species cited as the reason for or that would meet the criteria for Local Wildlife Site designation as a SINC (Grade B). Between 1% and 9% of the Greater London population of a species included in Red Data Birds in Britain, Birds of

examples of habitats listed on the London BAP and areas of UK BAP habitat that are large in extent within the context of London. A UK BAP habitat that is large in extent within the Regional context but is in an unfavourable condition would also be considered to be of Metropolitan value.

[ii] SINC (Grade B) = Site of Nature Conservation Importance (Grade II of Borough importance). These are sites that provide significant contributions to the ecology of the Borough. Selection is based on the availability of similar habitat in the Borough and the geographic relationship with nearby wildlife sites. This includes good examples of habitats listed on the Borough BAP.

Value (IEEM value in brackets)	**Ecological features**
	Conservation Concern Red or Amber List and/or on the *UK Biodiversity Action Plan* [UK BAP] Priority List) in any season. High numbers of foraging bats of a species listed under ‘National value’.
Low-medium (Local)	Habitat and/or species cited as a reason for the designation of a Local Wildlife Site as a SINC (Grade L)[iii]. A nature reserve designated at any other level that no longer meets the criteria for their designation, but meets the criteria for designation as a SINC (Grade L). A good example of a habitat, an assemblage of habitats, or population of species that appreciably enriches the local habitat resource. This includes mature native trees and scrub, species-rich semi-improved grassland, waterbodies, medium numbers of soprano pipistrelle bats, high numbers of common pipistrelle bats, small numbers of noctule bats and high numbers of invertebrates that would not meet the criteria for greater than local value. <1% of the Greater London population of a bird species of a species included in Red Data Birds in Britain, Birds of Conservation Concern Red or Amber List and/or on the UK BAP Priority List) in any season.
Low (site)	A larger area of habitat, such as amenity grassland, species-poor ephemeral/ short perennial vegetation, scrub young or non-native trees, that would not be of Local value or greater but contributes to urban green space in a landscape otherwise lacking in vegetation. Low numbers of common pipistrelle bats foraging on site.
Negligible (no significant resource)	Small areas of semi-natural habitat such as amenity grassland, ephemeral/short perennial, scrub and young trees. Very small numbers of common bird species, relative to their London populations. Buildings, hardstanding and river wall. Introduced scrub and/or non-native invasive species.

[iii] SINC (Grade L) = Site of Nature Conservation Importance (Grade I of Local importance). These are sites that provide significant contributions to the ecology of the local area and usually have other values such as nature study resources or they are run by local community groups. Selection is based on the availability of similar habitat in the local context and the relationship with nearby wildlife sites.

Base case

6.4.55 In the absence of development of other schemes, the base case for the project is considered to be the same as the baseline because it is not anticipated that the habitats and species associated with the site would materially change over the period between the time of survey and the start of construction. The only change to baseline conditions would therefore arise from the changes resulting from other developments in the vicinity of Thames Tideway Tunnel project sites.

6.4.56 The construction and operation of projects in the vicinity of the sites that could affect the base case in Site Year 1 of construction are described in the site-specific volumes (Section 6 of Vol 4 – 27).

6.5 Construction effects assessment

6.5.1 This section describes the assessment years and areas, and the methodology for assessing impacts and effects. The method for the valuation of ecological receptors is described in paras. 6.4.52 to 6.4.54 and Vol 2 Table 6.4.3.

Assessment years

6.5.2 While the peak period for likely significant effects on terrestrial ecology occur in the Site Year 1 of construction due to site clearance, activities that generate noise, vibration, lighting and movement on site would occur throughout the construction phase. Furthermore, landscaping and incorporation of ecological measures would be implemented at the final stages of construction. Therefore, impacts during the entire construction phase have been assessed.

Assessment areas

6.5.3 Within the terrestrial ecology realm, habitats and structures (river walls) from above the mean high water level are included in the assessment. The assessment area includes the site and immediate surrounds defined by the ecological features that could be affected by the proposed development. The extent of the assessment area is different for designated sites, habitats and species depending on a combination of connectivity with the site, likely significant effects and the characteristics of the ecological receptors (ie, movement of bats). The assessment areas for each site are described in the site assessment volumes (Section 6 in Vol 4 - 27).

Methodology

6.5.4 The assessment follows the *IEEM Guidelines*. The value of baseline ecological resources has been determined using desk based and field survey data, as described in Section 6.4, and the receptor identification and sensitivity criteria described in paras. 6.4.52 to 6.4.54 and Vol 2 Table 6.4.3. The likely significance of effects on ecological resources that may arise from the proposals during construction has then been assessed.

Significance criteria

6.5.5 The significance of effects on terrestrial ecology has been determined following the *IEEM Guidelines* with consideration to the value of the ecological receptor (Vol 2 Table 6.4.3), the magnitude of the impact, and the response of the ecological receptors.

6.5.6 The project has sought to mitigate all effects through embedded measures in the design and control measures implemented during construction through the *CoCP* as described in Section 6.10. The magnitude of impacts and significance of effects are determined after embedded measures have been applied.

Determining magnitude of impacts

6.5.7 The magnitude of impact is determined by describing the following features of the impacts based on the *IEEM Guidelines*:

a. Extent of impact, eg, extent of habitat loss, number of individuals of species that would be affected

b. Location of impact

c. The duration of the impact, eg, permanent or temporary

d. Timing and frequency of impact eg, 24 hours a day, night time only, for the duration of construction etc

e. Loss or gain in area and/or quality of habitat, and/or in population size of a notable species.

6.5.8 The magnitudes of the impacts of the proposed development (taking account of embedded measures such as the *CoCP*) are described qualitatively, in accordance with *IEEM guidelines*.

Determining significance of effects

6.5.9 The significance criteria apply the *IEEM Guidelines* to the project terminology. The assessment has used professional judgement to assess the likely effects of the change in the habitat resource or, populations, assemblages and distributions of species as a result of the impacts and to assess whether these effects would be significant under the following definitions (*IEEM Guidelines*):

a. Ecologically significant effect - 'an effect (either adverse or beneficial) on the integrity of a defined site or ecosystem and/or the conservation status of habitats or species within a given geographical area'.

b. Site integrity - 'the coherence of its ecological structure and function, across its whole area, which enables it to sustain the habitat, complex of habitats and/or levels of populations of the species for which it was classified.'

c. Effects on conservation status:

    i effects that may affect the habitats' long-term distribution, structure and functions

    ii effects that may affect the long-term distribution and abundance of the species' populations.

6.5.10 To allow for project-wide consistency, the significance levels applied in the IEEM Guidelines from site to international significance have been assigned a corresponding project significance level from negligible to major (adverse and beneficial) as shown in Vol 2 Table 6.5.1.

6.5.11 The term significance is used within the site assessment volumes to refer to these project significance levels. In line with the generic significance matrix (Vol 2 Table 6.5.1), effects that are moderate or major are considered to be significant and, if adverse, require mitigation (Vol 2 Table 6.5.1). Those effects that are minor are not considered to be significant. Therefore, minor or negligible adverse effects do not require mitigation (Vol 2 Table 6.5.1).

Vol 2 Table 6.5.1 Terrestrial ecology – significance criteria

Project significance level	Significance level based on the IEEM Guidelines
Major adverse	A significant negative effect that would be important at greater than metropolitan level (a significant decline in the population of a species of high (regional, national or international) value).
Moderate adverse	A significant negative effect that would be important at the local to metropolitan level (a significant decline in the population of a species of low-medium (local), medium (borough) or medium-high (metropolitan) value).
Minor adverse	A significant negative effect that would be important at less than local level (a significant decline in the population of a species of low (site) value).
Negligible	Effect that is nil or imperceptible and not significant (a change in the population of a notable species that would not be perceptible).
Minor beneficial	A significant positive effect that would be important at less than local level (a significant increase in the population of a species of low (site) value).
Moderate beneficial	A significant positive effect that would be important at the local to metropolitan level (a significant increase in the population of a species of low-medium (local), medium (borough) or medium-high (metropolitan) value).
Major beneficial	A significant positive effect that would be important at greater than metropolitan level (a significant increase in the population of a species of high (regional, national or international) value).

6.5.12 The level of confidence in the assessment of the significance of effects is determined according to the criteria shown in Vol 2 Table 6.5.2, as defined within the *IEEM Guidelines*. The level of confidence is based on professional judgement and considers a number of factors as detailed in the *IEEM Guidelines*.

Vol 2 Table 6.5.2 Terrestrial ecology – significance confidence criteria from IEEM Guidelines

Confidence	Criteria
Certain/near certain	Probability estimated at 95% chance or higher.
Probable	Probability estimated above 50% but below 95%.
Unlikely	Probability estimated above 5% but below 50%.
Extremely unlikely	Probability estimated below 5%.

6.6 Operational effects assessment

6.6.1 As stated in para. 6.1.4, operational effects have not been assessed for terrestrial ecology. The operational phase is therefore not considered in the assessment.

6.7 Cumulative effects assessment

6.7.1 The general approach to assessing cumulative effects is described in Section 3 General EIA methodology. The specific approach for terrestrial ecology is described below. The assessment years considered for the cumulative effects assessment remain as defined in para. 6.5.2.

6.7.2 Developments that could have a cumulative effect on ecological receptors have been identified with consideration to the timing, nature, scale and location of the development. The potential change in the magnitude of impacts on ecological receptors has been identified using the approach outlined in paras. 6.5.7 to 6.5.8. Any resulting change in the significance of effects on ecological receptors has been qualitatively assessed based on professional judgement.

6.8 Project-wide effects assessment

6.8.1 As stated in para. 6.1.5, no project-wide effects on terrestrial ecology are considered likely. Where there is potential for impacts on highly mobile species (birds and bats), the extent of these impacts would be localised and it is considered unlikely to affect the integrity of populations across the project area.

6.9 Assumptions and limitations

6.9.1 This section details general assumptions and limitations associated with the terrestrial ecology assessment. Site-specific assumptions and limitations are detailed in Section 6 in Vol 4 - 27. Despite the following assumptions and limitations, the assessment is considered to be robust.

Assumptions

6.9.2 As standard survey methodologies have been applied, unless otherwise stated, it is assumed that the results from survey visits are representative of the overall usage of the site. For example, for wintering birds, one visit a month was undertaken. It is assumed that this visit is representative of the usage of the site on other days in that month.

6.9.3 In the analysis of remote recording survey data, it has been assumed that bats would pass the remote recording device multiple times and that it is not possible to accurately estimate the number of bats that passed through the site during the survey. Therefore, the number of bat passes has been used as an indication of the level and type of bat activity on site.

Limitations

6.9.4 Survey methodologies follow standard guidance unless specific deviations from these have been described. However, a survey can only determine presence and likely absence. A species may be found on site at a later date.

6.9.5 Surveys have been undertaken within optimal survey periods wherever practicable. Where this has not taken place, the site-specific limitations are described within the site-specific volumes.

6.9.6 Surveys have been undertaken in optimal weather conditions wherever practicable. Where weather conditions influenced survey results, this is reported in the site assessment volumes

6.9.7 Remote recording bat survey equipment failed or partially recorded at a small number of sites. The surveys were either repeated or the data obtained was considered sufficient to trigger a further dawn survey. Therefore, the data obtained was considered to be sufficient for the purposes of the EIA. Where this has taken place, the site-specific limitations are described within the site-specific volumes.

6.10 Mitigation

6.10.1 The Thames Tideway Tunnel project has been designed to minimise environmental effects and therefore the construction design and methods take account of terrestrial ecology considerations. The findings of the assessment have been iteratively fed back into the design process to minimise adverse effects and promote beneficial effects where possible. The comments and suggestions of stakeholders raised at biodiversity workshops, biodiversity working group meetings and in responses to scoping, phase one and phase two consultation, have also been considered, and incorporated into the design where appropriate. Such measures have included the following:

a. careful selection of the development footprint to minimise habitat loss such as the avoidance of mature trees and sensitive designated sites
b. the provision of living roofs, bats boxes and other such features to promote biodiversity
c. noise minimisation through the provision of noise enclosures
d. permanent lighting design to minimise light spill
e. reinstatement and creation of habitats following completion of works to provide habitat of at least the same value as that lost
f. use of native species as part of landscape design.

6.10.2 Where such measures form part of the project, they are identified in Vol 1 (for the tunnel itself) and Section 3 of Vol 4 - 27 (for each site) and have been considered as embedded measures within the assessment. Details of these measures are also shown on the application drawings and included in the *Design Principles*. There is not a specific terrestrial ecology section in these principles since measures have been embedded in the relevant principles to ensure that ecological receptors are protected and enhanced as appropriate.

6.10.3 To protect and minimise disturbance to notable habitats and species as a result of construction activities on site, measures have been included in the *CoCP*. Part A of the *CoCP* presents measures that would be applied at all sites, while Part B presents measures that are site-specific. The *CoCP* forms part of the assessment and measures specific to the terrestrial ecology assessment are set out in Section 6.2 of the site assessment volumes. The *CoCP* includes details relating to the following:

a. measures to minimise the risk of pollution of surface water and watercourses such as storage of materials on site and methods of dewatering
b. noise control measures to minimise disturbance to birds and bats
c. restrictions to timing, location, type and direction of lighting on construction sites to minimise light spill onto adjacent habitats and minimising disturbance to birds and bats
d. specific measures to prevent harm to protected species such as pre-start checks, mitigation to prevent disturbance to bat roosts and exclusion measures to prevent harm to badgers
e. tree protection measures with a requirement to apply the British Standards (British Standards Institute, 2012)[32] to those trees to be retained
f. requirements for habitat reinstatement and creation.

6.10.4 Section 11 of *CoCP* Part A includes the requirement for an Ecology and Landscape Management Plan (ELMP) to be prepared for each site detailing how the measures set out in the *CoCP* would be implemented during construction. This document would also include a monitoring regime for habitats and species post-construction, to ensure the long-term success of habitat reinstatement and creation. A description of this monitoring is provided in Section 6 of Vol 4 - 27, where required.

6.10.5 Where the assessment indicates significant effects, having taken account of embedded measures, mitigation has been identified as appropriate.

6.11 Residual effects assessment

6.11.1 Where mitigation measures are proposed, residual effects are assessed by considering the magnitude of the impacts after mitigation measures have been applied and the resulting likely significance of the effects, using the method described in paras. 6.5.4 to 6.5.12.

6.11.2 Where no mitigation measures are proposed, the significance of residual effects remains as determined through the relevant site assessments.

This page is intentionally blank

References

[1] HMSO. *Biodiversity: the UK Action Plan*. HMSO (1994). Cm 2428.

[2] LBP. *London Biodiversity Action Plan*. London Biodiversity Partnership (2011).

[3] McLeod, CR, Yeo, M, Brown, AE, Burn, AJ, Hopkins, JJ, & Way, SF (eds.) *The Habitats Directive: selection of Special Areas of Conservation in the UK*. 2nd edn. Joint Nature Conservation Committee, Peterborough (2005). Available online at: http://jncc.defra.gov.uk/page-1457. Accessed on: 8 February 2012.

[4] JNCC. *The Birds Directive: Selection guidelines for Special Protection Areas.* Joint Nature Conservation Committee. Available at: http://jncc.defra.gov.uk/page-1405. Accessed on 8 February 2012.

[5]JNCC. *Guidelines for selection of biological SSSIs*. Conservancy Council 1989 (Revised 1998) currently under review. Available at: http://jncc.defra.gov.uk/page-2303#download.

[6] Natural England. *Local Nature Reserves in England: A guide to their selection and declaration*. Natural England (2010).

[7] The London Wildlife Site Board. Advice note: *Process for selecting and confirming Sites of Importance for Nature Conservation (SINCs) in Greater London*. The London Wildlife Site Board (June 2011). Available at http://www.london.gov.uk/sites/default/files/SINC%20Selection%20Process%20-%20final%20June%202011.rtf. Accessed on 8 February 2012.

[8] HM Government. *Natural Environment White Paper 2011 - The Natural Choice: securing the value of nature*. HM Government (2011).

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

[10]JNCC. *Handbook for Phase 1 Habitat Survey: A Technique for Environmental Audit.* Joint Nature Conservation Committee (2010).

[11] Eds. D. Ward, N. Holmes and P. José. *The new rivers and wildlife handbook*. R.S.P.B, N.R.A & R.S.N.C. (1994).

[12] Strachan, R. *The water vole conservation handbook*. RSPB, Environment Agency, English Nature & Wild CRU (1998)

[13] Harris S., Cresswell P. and Jefferies D. *Surveying Badgers*. Mammal Society (1989)

[14] BCT. *Bat Surveys: Good Practice Guidelines.* Bat Conservation Trust (2007).

[15] BCT. *Bat Workers Manual.* Bat Conservation Trust (2004).

[16] Marchant, J. H. *Common birds census instructions*, BTO (1983).

[17] Gilbert, G., Gibbons DW & Evans J. *Bird Monitoring Method*, RSPB (1998)

[18] Gilbert, G., Gibbons DW & Evans J. See citation above

[19] Gilbert, G., Gibbons DW & Evans J. See citation above.

[20] Froglife. *Froglife Advice Sheet 10: reptile survey*. Froglife (1999).

[21] Gent T and Gibson S. *Herpetofauna Workers Manual*. JNCC (2004).

[22] Oldham R S., Keeble J., Swan M J S. & Jeffcote M. *Evaluating the suitability of habitat for the Great Crested Newt (Triturus cristatus)*. Herpetological Journal 10(4), 143-155 (2000).

[23] English Nature. *Organising surveys to determine site quality for invertebrates: A framework guide for ecologists.* English Nature (2005).

[24] Rodwell JS. *National Vegetation Classification: Users' Handbook, JNCC National Vegetation Classification Field Guide Series*. JNCC (2000).

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

[26] Eaton MA, Brown AF, Noble DG, Musgrove AJ, Hearn R, Aebischer NJ, Gibbons DW, Evans A and Gregory RD. *Birds of Conservation Concern 3: the population status of birds in the United Kingdom, Channel Islands and the Isle of Man. British Birds* 102 (2009)

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

[28] Stewart A, Preston DA and Pearman CD. *Scarce Plants in British* (1994). Joint Nature Conservancy Council.

[29] Batten, L.A., Bibby, C.J., Clement, P., Elliot, G.D. &Porter, R.F. (1990). *Red Data Birds in Britain.* T. & A.D. Poyser, London.

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

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

[32] British Standards Institute. BS 5837:2012: *Trees in relation to design, demolition and construction – Recommendations*. BSI (2012).

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.02**

Volume 2: Environmental assessment methodology

Section 7: Historic environment

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

Hard copy available in

Box **16** Folder **A**
January 2013

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

This page is intentionally blank

Thames Tideway Tunnel

Environmental Statement

Volume 2: Environmental assessment methodology

Section 7: Historic environment

List of contents

Page number

List of tables

Page number

7 Historic environment

7.1 Introduction

7.1.1 This section sets out the methodology for assessing the likely significant effects of the Thames Tideway Tunnel project on the historic environment.

7.1.2 The methodology outlined in this section has been applied to all sites, unless otherwise indicated in the site assessment volumes. The methodology for assessing project-wide effects is also described.

7.1.3 The need for an assessment of historic environment effects results from the potential for the project to have an impact on the historic environment during the construction and operational phases of the project. The historic environment is defined in para 4.10.2 of the *National Policy Statement (NPS) for Waste Water* (Defra, 2012)[1] 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 landscapes.

7.1.4 Construction effects could arise from activities which remove, disturb or alter above ground or buried heritage assets, or their settings, or from changes to the fluvial regime of the River Thames around foreshore sites which could lead to scour of buried heritage assets, or from damage from ground movement generated by the works. Where relevant, physical effects on buried and above ground heritage assets, and effects on the setting of buried and above ground assets have been assessed during construction.

7.1.5 Operational effects could arise from changes in the character or setting of above ground heritage assets, due to the presence of permanent, visible structures or modifications to existing structures.

7.1.6 As the operational phase would not involve any activities below ground aside from maintenance confined within the tunnel infrastructure, an assessment has not been undertaken of operational effects on buried heritage assets. Furthermore, once operational, scour protection around foreshore structures would prevent scour affecting heritage assets, whilst in the deeper channel where contraction scour may occur it is very unlikely that archaeological remains would be present. Therefore no assessment of physical effects has been undertaken during operation.

7.1.7 The methodology described in this section sets out how each element of the assessment has been undertaken.

7.1.8 The topic specific methodology presented in this section builds upon the general assessment methodology summarised in Section 3 General EIA methodology of this volume and develops this to take account of the range of likely significant environmental effects on the historic environment arising from the construction and operation of the project.

7.1.9 A separate but related assessment of effects on townscape character and visual amenity has also been undertaken. The methodology is described in Section 11 Townscape and visual.

7.2 Engagement

7.2.1 The general approach adopted regarding engagement is summarised in Section 2 EIA process, consultation and engagement.

7.2.2 Throughout the assessment there has been ongoing liaison with English Heritage through regular meetings and with other stakeholders (local planning authorities, archaeological groups and individuals) regarding the assessment methodology, preliminary findings of the assessment including likely significant effects and proposed mitigation, and the design process. Site-specific consultation comments are included in Volumes 4 to 27 of the *Environmental Statement*. Consultation comments relating to the environmental impact assessment (EIA) methodology, and how each has been addressed, are detailed in Vol 2 Appendix E.1. The Infrastructure Planning Commission (IPC) provided comments on the *Scoping Report*, requesting consideration of a wide range of historic assets and overlap with the visual assessment. The IPC's comments are included in Vol 2 Appendix A.3 and have been addressed within this *Environmental Statement*.

7.3 Legislation and guidance

7.3.1 The methodology for carrying out the historic environment assessment follows established practice which has evolved from the legislation and guidance set out in paras. 7.3.2-7.3.8 below.

7.3.2 Nationally significant archaeological sites (both above and below-ground remains) can be identified as scheduled monuments and are protected under the Ancient Monuments and Archaeological Areas Act 1979.

7.3.3 Since 1990 archaeology has been a material consideration in the planning process and it is protected through planning policy and guidance detailed in para. 7.3.6 below.

7.3.4 The *Burial Act 1857*, the *Disused Burial Grounds Act 1884* and *1981*, the *Pastoral Measure 1983*, and the *Town and Country Planning (Churches, Places of Religious Worship and Burial Grounds) Regulations 1930* together provide a legal requirement for the exhumation and re-interment of human remains.

7.3.5 In terms of above ground assets, the *Planning (Listed Buildings and Conservations Areas) Act 1990* provides powers to protect designated above ground assets and forms the basis for defining receptor sensitivity in this assessment.

7.3.6 The assessment methodology also conforms to the requirements of national and local planning policy, including the following:

a. *National Policy Statement (NPS) for Waste Water*. A framework document for planning decisions on nationally significant waste water infrastructure (Defra, 2012)[2] – forms the main policy and guidance in relation to the Thames Tideway Tunnel project and sets out the requirement to define the significance of heritage assets.

b. *National Planning Policy Framework* (*NPPF*) (Department of Communities and Local Government, 2012)[3] – incorporates measures from previous planning policy guidance and statements for the historic environment, for example the requirement to ensure the mitigation response is proportionate to asset significance.

c. The *London Plan Spatial Development Strategy for Greater London* (Greater London Authority, July 2011)[4] and local planning authority policies - provide a framework for the protection of heritage assets and have informed the approach to mitigation.

7.3.7 The assessment methodology has also been informed by the following guidance:

a. *Conservation principles, policies and guidance*. (English Heritage, 2008)[5] – provides criteria for assessing the significance of heritage assets.

b. *The setting of heritage assets* (English Heritage, October 2011)[6] – sets out a staged approach to assessing effects on the setting of above ground and buried heritage assets, which has been applied to this assessment.

c. *Understanding historic buildings: a guide to good recording practice*. (English Heritage, 2006)[7], and the Department for Communities and Local Government and Department for Culture, Media and Sport, Revisions to principles of selection for listed buildings (March 2007)[8] - have informed baseline data gathering and identification of mitigation.

d. *Guidance on conservation area appraisals* (English Heritage, 2006)[9]; and *Guidance on the management of conservation areas* (English Heritage, 2006)[10] – have been used to inform assessment of asset significance of conservation areas.

e. *London's World Heritage Sites Supplementary Planning Guidance* (Mayor of London, March 2012)[11] – sets out guidance on the conservation of World Heritage Sites and their setting and has been referenced in relation to the assessment of effects on the setting of the Palace of Westminster World Heritage Site.

f. *PPS5 Planning for the Historic Environment: Historic Environment Planning Practice Guide* (Department of Communities and Local Government, English Heritage & Department for Culture, Media and Sport, March 2010)[12] – whilst PPS5 has been replaced by the *NPPF*, this practice guide remains extant, and has been used to inform assessment of asset significance. It states that an integrated approach to the historic environment (above ground and buried assets) should be adopted and that the impact of the project on both designated and undesignated assets should be considered

g. *By-laws, standards and policy statements of the Institute of Field Archaeologists, standard and guidance: desk based assessment* (Institute for Archaeologists, 2001)[13] - provides detailed technical guidance and standards for archaeological assessment and has informed the approach to compiling the baseline.

h. *Standards for Archaeological Work London Region, External Consultation* (Greater London Archaeological Advisory Service, 2009)[14], and. *Planning Advice Note 3: Archaeology in the City of London, Archaeology Guidance* (City of London Corporation of London Department of Planning and Transportation, 2004)[15] - provide detailed technical guidance and standards for archaeological work undertaken in Greater London boroughs and the City of London Corporation and have informed the approach to mitigation.

i. The London Research Framework (Museum of London and English Heritage, 2002)[16] and the Greater Thames Estuary Historic Environment Research Framework (English Heritage 2010)[17] - have been used to identify themes that encompass the historic environment assets along the Thames Tideway Tunnel project route for the purposes of informing the *OAWSI*.

7.3.8 Vol 2 Table 7.3.1 presents the requirements within the NPS relevant to the historic environment and explains how the requirements have been addressed within the *Environmental Statement*. The table also gives the location of the relevant material.

Vol 2 Table 7.3.1 Historic environment – requirements of the NPS and how they have been addressed

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
The construction, operation and decommissioning of waste water infrastructure has the potential to result in adverse impacts on the historic environment (para 4.10.1)	For each site where the historic environment may experience impacts during construction or operation, likely significant effects have been assessed.	Full details can be found in the *Environmental Statement* volumes covering the individual TTT sites, Vols 4-27. A *Project wide assessment* of likely significant effects is contained in Vol 3.
Para 4.10.2 of the NPS defines the historic environment, and heritage assets which form part of the historic environment. It notes that the sum of the heritage interests that a heritage asset holds is referred to as its significance.	The NPS definition of the historic environment and heritage assets is recognised in the *Environmental Statement*. The significance of heritage assets is defined in the *Environmental Statement.*	Heritage assets and their significance are identified within Section 7.4 (baseline conditions) of each site volume.

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
Para 4.10.3 notes that some heritage assets have a level of significance that justifies official designation.	Assets with official designation within the assessment area defined for each Thames Tideway Tunnel site are recognised as receptors in the *Environmental Statement* and their significance defined accordingly.	Officially designated assets are described within Section 7.4 of each site volume.
Paras 4.10.4 and 4.10.5 detail that there are often heritage assets with archaeological interest that are not currently designated as scheduled monuments, but which are demonstrably of equivalent significance, and that the absence of designation does not indicate lower significance. In such cases the heritage asset should be considered subject to the same policy considerations as those that apply to designated heritage assets	The *Environmental Statement* assesses the impact of the project on all heritage assets, whether formally designated or not. Professional judgement has been used to determine the heritage significance of those assets which are not designated.	Undesignated assets are described within Section 7.4 of each site volume. The assessment of effects is set out in Sections 7.5-7.7 and 7.9 of each volume.
Para 4.10.6 notes that the decision maker should also consider the impacts on other non-designated heritage assets, where the assets have a significance that merits consideration in its decisions, even though those assets are of lesser value than designated heritage assets.	As above	As above
Para 4.10.7 requires that as part of the ES the applicant should provide a description of the significance of the heritage assets affected by the proposed development and the contribution of their	The *Environmental Statement* provides a description of heritage significance for each heritage asset that is potentially affected by the proposed development, and the contribution of their	Heritage assets and their setting are identified and their significance is evaluated within Section 7.4 of each site volume.

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
setting to that significance.	setting to significance.	
Para 4.10.8 sets out the requirement to determine the archaeological interest of a development site, using appropriate methods.	The *Environmental Statement*, including the supporting technical appendices, comprises an appropriate desk-based assessment, which also reflects the findings of borehole analysis and walkover surveys of each site.	The archaeological baseline of each site is detailed within Section 7.4 of each site volume.
Para 4.10.8 indicates that where proposed development will affect the setting of a heritage asset, representative visualisations may be necessary to explain the impact.	Visualisations have been prepared as part of the townscape and visual assessment and have informed the assessment of effects on the setting of heritage assets.	Visualisations are included where appropriate within Section 11 of each site volume.
Para 4.10.9 states that the applicant should ensure that the extent of the impact of the proposed development on the significance of any heritage assets affected can be adequately understood from the application and supporting documents.	The *Environmental Statement* presents a clear and detailed assessment of likely significant effects on heritage assets.	Section 7 of Volume 3 Project-wide and Section 7 of each site volume.
Para 4.10.12 requires the decision maker to take into account the desirability of sustaining and, where appropriate, enhancing the significance of heritage assets, and developments contributing to the character and local distinctiveness of the historic environment. The decision maker should have regard to any relevant local authority development plans.	The *Environmental Statement* assesses effects on the significance of heritage assets, taking into account the contribution of their settings, and effects on the character and appearance of designated historic areas. The degree to which the proposals adhere to local policies is addressed in the relevant site appendices of the *Heritage Statement* (that accompanies the	Section 7 of each site volume. The *Heritage Statement*.

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
	application).	
Para 4.10.13 sets out a presumption in favour of the conservation of designated heritage assets and the more significant the designated heritage asset, the greater the presumption in favour of its conservation should be. Loss affecting any designated heritage asset requires clear and convincing justification. Substantial harm to or loss of a grade II listed building, park or garden should be exceptional. Substantial harm to or loss of designated assets of the highest significance, including Scheduled Monuments, registered battlefields, grade I and II* listed buildings, grade I and II* registered parks and gardens, and World Heritage Sites, should be wholly exceptional.	The assessment methodology differentiates between heritage assets according to their significance. Thus the sensitivity of assets is taken into consideration in the assessment of likely significant effects. Vol 2 Table 7.5.3 describes how effect significance equates to substantial and less than substantial harm.	Section 7 of Volume 3 Project-wide and Section 7 of each site volume.
Para 4.10.14 requires that any harmful impact on the significance of a designated heritage asset should be weighed against the public benefit of development, recognising that the greater the harm to the significance of the heritage asset the greater the justification will be needed for any loss.	The *Environmental Statement* assesses the likely significant effects of the proposals upon the historic environment at each site, in line with the relevant historic environment policies of the NPS and other guidance as appropriate. However, it is not the purpose the ES to weigh up harm versus public benefit. This analysis is presented within the *Planning Statement*.	The *Planning Statement*.
Para 4.10.15 notes that not all elements of a World	The *Environmental Statement* considers the	Section 7 of each site volume.

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
Heritage Site or Conservation Area will necessarily contribute to its significance. The policies in paragraphs 4.10.10–4.10.14 apply to those elements that do contribute to the significance. The decision maker should take into account the relative significance of the element affected and its contribution to the significance of the World Heritage Site or Conservation Area as a whole.	extent and nature of each relevant element of a WHS or CA, and its contribution to the significance of the asset as a whole. The assessment of effects on the significance of the asset take into account the relative significance of the element affected.	
Para 4.10.17 notes that when considering applications for development affecting the setting of a designated heritage asset, the decision maker should treat favourably applications that preserve those elements of the setting that make a positive contribution to, or better reveal the significance of, the asset. When considering applications that do not do this, the decision maker should weigh any negative effects against the wider benefits of the application.	The assessment identifies the contribution made by the setting to the significance of the heritage asset. Where the significance is preserved or enhanced it is identified as a negligible or beneficial effect in the *Environmental Statement*. Where the proposals make a positive contribution to or better reveal the significance of the asset, this is identified within the ES and also identified within the relevant site appendix of the *Heritage Statement*.	*Heritage Statement*
Para 4.10.18 states that applicants should aim to design the proposal to avoid unnecessary damage but also ensure that any unavoidable losses are recorded.	The *Environmental Statement* describes the process of design iteration. Wherever possible, this process has enabled the conservation of the significance of heritage assets or where not possible that any impacts would be minimised,	The process of engagement with statutory consultees and stakeholders, which has helped to refine the proposals, is described within Section 7.3 of each site volume. Mitigation measures are detailed in Section 7.8 of each site

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
	including through high quality design of new elements. Where damage to or loss of heritage assets is unavoidable, and where the significance of the asset is such that preservation by record is considered by professional judgement to be sufficient to mitigate the adverse effect, such mitigation is proposed within the *Environmental Statement*.	volume.
Para 4.10.19 states that a documentary record is not as valuable as retaining the heritage asset and therefore the ability to record evidence of the asset should not be a factor in deciding whether consent should be given.	It has been agreed with English Heritage that preservation by record and the enhancement of understanding of asset significance is the most appropriate measure to mitigate the adverse effects identified in the *Environmental Statement*. The separate issue of whether consent should be given is addressed in the *Planning Statement*.	N/a
Para 4.10.20 requires that where the loss of the whole or a material part of a heritage asset's significance is justified, the applicant should record and advance understanding of the significance of the heritage asset before it is lost. This should be in accordance with a written scheme of investigation.	The *Environmental Statement* details a mitigation strategy of preservation by record with cross-reference to an *Overarching Archaeological Written Scheme of Investigation*.	Mitigation measures are detailed in Section 7.8 of each site volume and Appendix E2 contains an *Overarching Archaeological Written Scheme of Investigation (OAWSI)* which sets out the process by which assets would be recorded and findings documented and disseminated.
Para 4.10.21 requires that where the decision maker considers there to be a high probability for	The *Environmental Statement* considers the impact of the project on possible, unknown	Appendix E2 contains an *Overarching Archaeological Written Scheme of Investigation*

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
unknown archaeological assets, they should ensure that appropriate procedures are in place for the identification and treatment of such assets discovered during construction	archaeological assets. Expert professional judgement has been used to identify the likely potential for such remains being present and their possible significance. Mitigation measures are detailed to ensure the identification and treatment of such assets during construction.	*(OAWSI)* which sets out the process by which mitigation would be undertaken during construction, including in relation to any unexpected finds.

7.4 Baseline data collection

7.4.1 Baseline data collection has involved desk-based research and field survey for each site to establish the nature of below and above ground heritage assets within and around each site, including archaeological remains, buildings, structures, monuments and landscapes, and their settings.

7.4.2 The project-wide baseline has been established through desk-based research and field survey along the main tunnel alignment to identify the presence and nature of heritage assets which could be subject to ground movement effects.

7.4.3 The following sections describe the site-specific baseline data gathering methodology, followed by the project-wide data gathering methodology.

Desk based baseline data

Site-specific

7.4.4 The desk based data collection has generally extended to a radius of approximately 250m around the centre point of each site in order to inform the understanding of the historic environment potential within each site, including information on the nature and likely date of any above ground assets within the site or immediately adjacent. Occasionally, a wider area has been used where there is insufficient baseline data within 250m to characterise the potential for buried heritage assets. In some cases, reference is made to heritage assets outside the defined baseline area, where such assets are particularly important or where they contribute to understanding of the archaeological potential of the site.

7.4.5 Baseline data for the assessment of effects on the historic character and setting of above ground heritage assets has been gathered within the assessment area for the setting assessment. This is detailed in paras.7.5.9 and 7.6.5 for construction and operation, respectively.

7.4.6 Vol 2 Table 7.4.1 details all desk-based data sources used. The Greater London Historic Environment Record (GLHER), the National Heritage

List, managed by English Heritage, and the London Archaeological Archive and Research Centre (LAARC), managed by the Museum of London, have been used to obtain the majority of the baseline data. The GLHER includes information from past investigations, local knowledge, find spots, and documentary and cartographic sources. The National Heritage List includes all statutorily designated heritage assets. LAARC is a public archive of past investigations.

7.4.7 Information from the Thames Discovery Programme (TDP) on structures of heritage interest on the foreshore also forms part of the baseline, as does data from Seazone, a marine digital data provider, on recorded wrecks and obstructions (of potential archaeological interest) compiled from the UK Hydrographic Office (UKHO) database. The Port of London Authority (PLA) was contacted but it holds no additional publicly available information on wrecks.

7.4.8 Bathymetric data held by Thames Tideway Tunnel project has been used to interpret where scour or dredging has occurred (since dredging could affect archaeological survival). Relevant organisations were contacted for information on past dredging within the Thames channel, but no such information was obtained.

Project-wide

7.4.9 Along the alignment of the tunnel, desk-based baseline information has been gathered on statutorily designated assets (ie listed buildings and scheduled monuments) which could be affected by ground movement caused by deep excavations, demolitions, construction works and tunneling. Data was gathered from English Heritage's National Heritage List and from local authorities.

Vol 2 Table 7.4.1 Historic environment – desk based baseline data sources

Source	Data	Notes
English Heritage National Monuments Record (NMR)	Statutorily designated heritage assets, comprising: world heritage sites; scheduled monuments; statutorily listed buildings; registered parks and gardens; historic battlefields.	
Greater London Historic Environment Record (GLHER)	Historic Environment Record database search within a defined assessment area around each site.	One of the primary repositories of archaeological information within the Greater London. Includes information from past investigations, local knowledge, find spots, and documentary and cartographic sources.
Local authorities	Conservation areas (boundary extent and character appraisals), archaeological priority areas/zones (boundary extent), locally listed buildings.	
Landmark Information Group	Ordnance Survey maps from 1st edition (1860–70s) to present day.	Provides an indication of the possible date of any buildings on the site. Past land use and impacts may have compromised archaeological survival.
London Archaeological Archive and Research Centre (LAARC)	Public archive of past archaeological investigations managed by the Museum of London.	Contains summary information of findings. The paper archive held at LAARC was also consulted in detail where more detailed information was required.
Museum of London Archaeology (MOLA)	GIS data sets include digitally plotted burial grounds from the Basil Holmes late 19th century survey, geo-referenced historic maps and digitised features (eg, projected lines of Roman roads, Civil War defences), extensive range of archaeological reports and geoarchaeological data, and the MOLA archaeological deposit survival archive.	

Source	Data	Notes
Thames Discovery Programme (TDP)	Thames GIS database with information from the 1990s Thames Foreshore Survey (the ‘Alpha Survey’). Most of the data (over 2,000 records) has not yet been incorporated into the GLHER.	Survey of visible remains on the Thames foreshore, such as old wharves, jetties, barge beds and other structures.
Libraries and record offices including the British Library, the London Society Library, the London Metropolitan Archives and Local authority Record Offices	Historic maps, architectural/engineering records and published histories.	Can provide information on past land use, past disturbance and assets which are not currently on the GLHER.
Local amenity societies	Unpublished information on archaeological investigations and foreshore walkover surveys carried out by amenity societies, eg Wandsworth Historical Society.	Information on assets which are not currently on the GLHER
Seazone	UK Hydrographic Office data on recorded wrecks within the Thames channel.	Wrecks may be of archaeological interest.
British Geological Survey (BGS)	Digital geology data.	Subsurface deposition, including buried geology and topography, can provide an indication of potential for early human settlement, and potential depth of remains.
Thames Water	Geotechnical borehole data, topography, services and drainage surveys.	Geotechnical data provides an indication of the nature and depth of subsurface deposits and potential archaeological remains. Topographic data provides information on current ground levels which is used to compare against depth of archaeological remains. Services and drainage infrastructure could

Source	Data	Notes
		indicate past impacts on archaeological remains.
Thames Water	Historic ‘works as executed’ drawings relating to various Thames Water sites, including Abbey Mills, Falconbrook and Hammersmith Pumping Stations and other Thames Water sewerage infrastructure. These drawings date from the 1860s up to the 1920s.	These drawings can provide information on the nature and historic significance of assets. They can also provide information on existing foundations, which may have removed archaeological remains.
Thames Water	Bathymetric data for the River Thames channel.	Contour data provides an indication of the depth of alluvium, presence of archaeological remains within channel silts, and evidence of past scour and dredging.

Field survey baseline data

Site-specific

Site visits

7.4.10 Reconnaissance inspections were made of each site in early 2011 to inform the scope of the assessment of effects on the historic environment. This entailed viewing each site from publicly accessible land, recording any features of historic interest through photography and notes.

7.4.11 Detailed site walkover inspections were carried out in 2011 and 2012. The site walkover inspections comprised a visual inspection (with associated notes and photography) to identify heritage assets visible above ground, and to note site configuration and formation levels (for basements and other subterranean features) which could have altered the potential for the survival of buried heritage assets. The heritage significance of above ground assets was assessed (as defined in para. 7.4.21), the condition in which they currently survive was noted and, where appropriate, an inspection was made of the interior of buildings of architectural or historical interest. Also considered on the walkover was the context of heritage assets within and around the sites, for example noting the presence of any associated structures beyond the site boundary.

7.4.12 A further site walkover was undertaken in early 2012 for the assessment of effects on the historic character and setting of above ground heritage assets. The site walkover comprised a visual inspection (with associated notes and photography) of the setting of each identified heritage asset, including consideration of views to and from each asset.

7.4.13 Internal and external inspections of listed buildings within the zone of 1mm or more of predicted potential ground movement induced by deep excavations, demolitions and tunnelling within Thames Tideway Tunnel project sites were undertaken in order to confirm the heritage significance and existing condition of the buildings in terms of both structure and architectural finishes (good, poor, very poor) and thus their sensitivity to movement or change. In addition inspections were undertaken for listed bridges and sections of listed river wall within Thames Tideway Tunnel project sites.

Geoarchaeological monitoring of geotechnical investigations

7.4.14 Geotechnical investigations consisting of boreholes and trial pits have been carried out at Thames Tideway Tunnel project sites for engineering design purposes. A number of these were monitored for archaeological purposes where it was thought that they could provide useful baseline data, for example information on the nature and depth of subsurface deposits, particularly in areas where there is a little or no existing information. Understanding the nature and depth of subsurface deposits is a valuable predictive tool for understanding archaeological and palaeoenvironmental potential. The latter comprise remains related to past environments, dating to the prehistoric and later periods. Such remains can be of archaeological interest, and often consist of organic remains such as pollen and plant macro fossils which can be used to reconstruct the past environment.

Project-wide

7.4.15 In addition to baseline inspections of heritage assets affected by deep excavations within Thames Tideway Tunnel project sites, internal and external inspections of listed buildings and structures within the zone of 1mm or more of settlement predicted to be induced by the main tunnel and connection tunnels have been undertaken. The inspections were undertaken in order to confirm the heritage significance and existing condition of the buildings (good, poor, very poor) and thus the sensitivity of their significant elements to damage from ground movement or change. Further details of the methodology used is detailed in the listed buildings damage assessment report which is appended (see Vol 2 Appendix E.3). In addition inspections have been undertaken for listed bridges, viaducts and sections of river wall along the alignment of the tunnels.

Receptor identification and sensitivity

7.4.16 The baseline data has been examined in order to determine the likely nature, extent, preservation and significance of any heritage assets that may be present within each site and the associated assessment area, and the nature of their settings.

7.4.17 Known individual historic environment features within the assessment area for each site have been allocated a unique historic environment assessment reference number (**HEA 1, 2,** etc), which is listed in a gazetteer in an appendix to each site-specific assessment, and shown on a historic environment features map.

7.4.18 Much of the archaeological resource is buried and therefore asset potential has been predicted from the distribution of known heritage assets and information from historic maps, geology, geoarchaeology, topography, and factors which may have compromised archaeological survival.

7.4.19 There are two broad categories of historic environment receptors:

a. Buried heritage assets (archaeological remains). These may either be known assets, or possible unrecorded archaeological remains, whether designated or not. The assessment considers the likely nature, date, extent, survival and significance of such assets. This category also includes assets that are permanently underwater. Assets on the foreshore that are temporarily underwater and which are mostly buried and only partly exposed at low tide are also included in this category.

b. Above ground heritage assets (built heritage). These largely comprise standing buildings of historic interest, including statutorily and locally listed buildings, World Heritage Sites and their settings, and conservation areas and Registered Parks and Gardens, and their character and settings. Above ground heritage assets also include built heritage that has not been designated but which has been identified during the course of the assessment as having heritage interest.

7.4.20 The EIA generally uses the term ‘value’ to define the sensitivity of an environmental receptor, however value has a different meaning in the historic environment topic. The historic environment topic uses ‘asset significance’ rather than value to define sensitivity of environmental receptors. The historic environment assessment also distinguishes between the significance of the resource - asset significance and significance of the environmental effect.

7.4.21 The determination of asset significance of known and potential heritage assets is based on statutory designation, or in the absence of designation, professional judgement against four values set out in English Heritage *Conservation Principles* (English Heritage, 2008)[18]:

a. *Evidential value*: the potential of physical remains to yield evidence of past human activity.

b. *Aesthetic value*: this derives from the ways in which people draw sensory and intellectual stimulation from the heritage asset.

c. *Historical value*: this derives from the ways in which the past can be connected through heritage assets to the present.

d. *Communal value*: this derives from the meanings a heritage asset has for the local people.

7.4.22 These values encompass the criteria, such as special architectural, historic interest, or archaeological interest that English Heritage are obliged to consider when statutorily designating heritage assets.

7.4.23 Vol 2 Table 7.4.2 below defines receptor value ie, asset significance of designated and non-designated, above ground and buried heritage assets.

Vol 2 Table 7.4.2 Historic environment – asset significance criteria

Asset significance	Definition
High	World heritage sites Scheduled monuments Grade I, II*, II listed buildings English Heritage Grade I, II*, II registered Parks and Gardens Conservation areas Burial grounds Undesignated heritage assets as defined through the process defined in above. Protected Wrecks, Designated historic battlefields, protected heritage landscapes (eg, ancient woodland or historic hedgerows) are also assets of high significance but do not fall within the project baseline
Medium	Undesignated heritage assets as defined through the process defined in paras 7.4.21–7.4.25. Locally listed buildings.

Asset significance	Definition
Low	Undesignated heritage assets as defined through the process defined in paras 7.4.21–7.4.25.
Negligible	Undesignated heritage assets as defined through the process defined in paras 7.4.21–7.4.25.
Uncertain	Applies to areas where past human activity is likely but where there is not enough evidence to assess potential or assign significance.

7.4.24 In relation to buried heritage assets, professional judgement has been used to predict the likely significance of these assets based on likely nature, date, extent, survival, condition, rarity, group value, and the four value criteria above. These criteria have also been used to determine the asset significance of undesignated above ground structures. There is no single defining criterion that dictates the overall asset significance; each asset has to be evaluated against the range of criteria listed above on a case by case basis.

7.4.25 In relation to above ground designated heritage assets, and known buried heritage assets, the assessment takes into account the contribution which the historic character and setting makes to the overall significance of the asset and also the role that Thames Tideway Tunnel project sites play in that contribution. There is no single defining set of criteria for quantifying the contribution of setting to the significance of an asset; professional judgement has therefore been used in relation to each identified asset on a case by case basis to arrive at a qualitative judgement on the contribution of the setting to the significance of the assets. This process takes into account the historic context of each asset, architectural and design purpose and the intended and/or incidental views to and from each asset.

7.4.26 Views make a particular contribution to setting, in particular in relation to Thames Tideway Tunnel project sites in prominent riverside locations. Protected London Views are considered in the Townscape and Visual sections of each site assessment (Section 11 of each site volume). More localised and heritage specific views that form part of the character or setting and significance of heritage assets have been identified as part of the baseline. For the purposes of this assessment they have been called ‘Views of Heritage Value’ (VHV) and are marked on the relevant figure in each site volume. These have been either derived from existing conservation area appraisals or from observations made in the field, through historical research and through an understanding of historic context and design intentions. The views have no statutory designation or protection in themselves; but form part of the significance of particular assets and are intended to illustrate the views described in the text.

Base case

7.4.27 The base case is the future baseline in the assessment year, reflecting any changes compared to the current situation, which would result from other developments in the intervening period or due to other factors such as scour of the Thames foreshore.

7.4.28 The base case for above ground and buried heritage assets within each site is unlikely to change from the existing baseline. 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 fluvial erosion is changing the archaeological baseline within some foreshore sites, as the rate of erosion is not known, the base case is assumed to be as per the baseline.

7.4.29 Furthermore, no non-Thames Tideway Tunnel schemes are anticipated that would lead to physical changes in above ground or buried heritage assets within any of the Thames Tideway Tunnel project sites. Site development schedules, appended to each site volume of the *Environmental Statement* as Appendix N, list all major non-Thames Tideway Tunnel project developments within 1km of each site. Whilst the baseline within the baseline area around each Thames Tideway Tunnel project site may change as a result of any archaeological excavation and recording carried out as part of a standard program of mitigation for such developments, such information is unlikely to significantly change the current understanding of the historic environment of each site.

7.4.30 The historic character of conservation areas and registered parks and gardens and the setting of above ground heritage assets may change due to the presence of non-Thames Tideway Tunnel project developments within the year of assessment. Changes in the baseline are therefore considered in each site-specific assessment volume. Typically other developments in close proximity to Thames Tideway Tunnel project sites may be relevant, whilst sites further away may not be relevant due to their distance from the site, meaning that they are less visible or reduced in scale in relation to the Thames Tideway Tunnel project site, or the intervening presence of other buildings and/or mature vegetation that acts as a barrier even in winter.

7.5 Construction effects assessment

7.5.1 This section describes the approach to assessing the effects of construction at each Thames Tideway Tunnel project site. The approach to assessing project-wide effects is detailed in Section 7.8 below.

Assessment years

7.5.2 In terms of physical effects on above ground or buried heritage assets caused directly by construction activity, likely significant effects could arise throughout the construction phase. Effects arising from all stages of the construction period are therefore assessed.

7.5.3 In terms of assessing the effects of construction phase induced ground movement on listed buildings and structures, the period of the most significant movement would be during and just after demolitions, deep excavations and tunneling works. Although ground movement generated by these activities would be likely to continue into the operation phase and non-emergency repairs of significant damage caused by ground movement would also take place in the operation phase, the ground movement would be caused by construction works and would be most pronounced during the construction period. The effects of ground movement are therefore assessed in the construction phase. As ground movement would commence during preliminary demolitions and continue beyond the construction period, the assessment of ground movement covers the whole construction phase, rather than a specific year.

7.5.4 In terms of assessing construction phase impacts on the setting of above ground heritage assets, the peak construction year has been used. This varies from site to site, and is defined in each site-specific assessment volume for the historic environment, along with the particular aspects of the project which could impact on the historic environment.

7.5.5 In addition, consideration is given to the extent to which the construction assessment findings for effects on the character, appearance and setting of heritage assets would be likely to vary materially from those assessed should the programme for the Thames Tideway Tunnel project be delayed by approximately one year.

Assessment areas

7.5.6 With the exception of effects from ground movement, the construction assessment area for physical effects on above ground or buried heritage assets is defined by the site boundary.

7.5.7 The assessment of the effects of construction induced ground movement is based on the model of ground movement predicted in the engineering damage assessment. The area of assessment encompasses the zone of settlement predicted to result from all construction phase activities, and therefore includes all listed buildings and structures that are expected to be affected by 1mm or more of predicted ground movement.

7.5.8 The area for assessing effects on the setting of known buried heritage assets of high significance is defined by available baseline information and professional judgement, and may extend beyond the site boundary.

7.5.9 The assessment area for the setting assessment of above ground heritage assets has been defined with reference to the Zone of Theoretical Visibility (ZTV) of Thames Tideway Tunnel project infrastructure (generated for the townscape and visual assessment, as described in Section 11 of this volume), using professional judgement to determine which assets could potentially be subject to significant effects. Not all heritage assets that fall within the ZTV have been assessed due to the presence of intervening vegetation (which is not evident in the ZTV model), the limiting effect of intervening buildings and the diminishing effect of distance. Therefore, only those heritage assets affected are described in the *Environmental Statement.*

Methodology

7.5.10 In accordance with the *NPS* (Defra, 2012)[19] *for Waste Water* and the *NPPF* (Department of Communities and Local Government, 2012)[20], the approach employed in the assessment of effects on the historic environment has been to consider the impact of the proposed development on the significance of heritage assets (described in Vol 2 Table 7.4.2 above). The methodology first describes how physical effects on above ground buried heritage assets are assessed, followed by effects on the setting of heritage assets.

Assessment of physical effects

7.5.11 The following sub-sections detail how physical effects arising from a range of impacts have been assessed.

Ground disturbance

7.5.12 The identification of physical impacts on buried heritage assets within a site takes into account any construction phase activity which would entail ground disturbance, for example site set up works including utility diversions, footings of temporary welfare facilities, or the excavation of shafts, chambers and culverts. The potential impact of scour around temporary structures is also considered.

Removal or alteration of assets

7.5.13 The identification of physical impacts on above ground heritage assets within a site takes into account any works which would remove, alter, or otherwise change the fabric of an upstanding structure of historic interest, such as the demolition of sections of historic river wall, works to existing pumping stations, the temporary removal of listed street furniture, or intrusive works to protect the significance of listed buildings from the effects of tunnel and construction induced ground movement.

Compression of foreshore deposits

7.5.14 It is assumed for the assessment that the majority of foreshore material within the temporary cofferdams would remain in situ. For structural reasons, soft material located adjacent to the perimeter of the temporary cofferdams and adjacent to the river wall would be removed. The soft material includes silt, peat and other materials. All soft material within permanent cofferdams would be removed to ensure sound foundations for permanent construction. Areas of removed material would be filled with gravel. Cofferdam fill material would then be placed onto the foreshore on top of a geotextile layer.

7.5.15 The impact of compression from the placement of up to 10m thickness of fill material, as assumed for the purposes of the assessment, upon buried heritage located within and beneath the foreshore alluvium is uncertain. Whilst there has been some research there is no detailed data or formulae that can be applied to the Thames Tideway Tunnel foreshore sites. Various factors are likely to influence the survival of archaeological remains under fill, including:

a. the structure and composition of the soils. Silt is more susceptible to compression than granular soils[21], although with granular soils the additional stress is transferred to buried artefacts more directly and therefore the potential for damage is possibly higher[22]. Peat can continue to deform under constant load after initial consolidation[23].

b. aerobic conditions - the introduction of oxygen into deposits that are no longer waterlogged can increase the deterioration of archaeological materials[24]. However, the process of introducing cofferdam fill material is unlikely to introduce such conditions to foreshore deposits.

c. soil chemistry and the nature of cofferdam fill could lead to the deterioration of organic and other remains[25].

7.5.16 All buried environments are dynamic and it is generally accepted that preservation is more likely if archaeological deposits and features are maintained in conditions as close as possible to the environment that has enabled them to survive in the first place.

7.5.17 The confining pressure afforded from soil surrounding a buried heritage asset would typically be about one-half of the vertical pressure applied, in this instance from fill within the temporary cofferdam. Consequently, certain types of materials may compress given the weaker confining pressure. For the purposes of this assessment it has been assumed that where archaeological remains within the foreshore contain voids and/or are made of porous/organic material (such as timber structures/objects such as wattle, fishtraps, and peat), the loading compression predicted to occur is likely to cause some damage. Where such remains are solid, non-porous and inorganic without voids, such as metal, stone, flint, and brick, they are unlikely to be damaged. Whilst water in the foreshore deposits would be displaced, the deposits are likely remain moist and anaerobic and there would therefore not be further deterioration to organic heritage assets from drying out.

Dewatering

7.5.18 Effects of dewatering on buried heritage have been considered, but it has been concluded that this would not have an impact on heritage assets at or around any Thames Tideway Tunnel project sites and is therefore not considered further in the site assessments. This is because dewatering would occur in the lower aquifer, at a level too deep to affect any archaeological remains. Such remains might be within the upper aquifer, which is separated from the lower aquifer by low permeability Lambeth Group deposits and London Clay. In parts of east London, the Lambeth Group and London Clay are absent and the upper and lower aquifers are potentially in hydraulic continuity. At four of the sites in that area (Abbey Mills, Deptford Church Street, Greenwich and Earl Pumping Stations), the shafts would be constructed using diaphragm wall methods, which effectively form a seal around the shafts and would only deploy internal dewatering techniques within the shaft itself, within which any archaeological remains would have been removed by the shaft excavation. Any archaeological remains in the aquifer outside the shaft footprint would be unaffected.

Intrusive mitigation to listed buildings

7.5.19 The assessment of physical effects resulting from construction activities has also considered whether intrusive mitigation to listed buildings, such as the installation of secondary glazing (ie, which would potentially have a physical impact on the fabric of the building), may be required to mitigate effects of construction noise. A process of reviewing the representative sensitive receptors within the assessment area identified for inclusion in the noise assessment (see Section 9 Noise and vibration of this volume) to identify whether any of these receptors, or those they represent, are listed has been undertaken. For further details of the noise assessment methodology see Section 9 Noise and vibration. No listed buildings requiring secondary glazing have been identified.

Ground movement

7.5.20 For the assessment of the effects of ground movement on listed buildings and structures, each listed building or structure has been assessed for its sensitivity to settlement impacts using established accepted methods, based on those used in other major tunnelling projects in the UK.

7.5.21 Listed buildings have been assessed based on the model developed by Burland *et al* (1995)[26] for the assessment of ground movement impacts to masonry buildings. The assessment uses a combination of geotechnical, structural and in this case heritage significance information and information on the condition of the building to create a numerical score for each building based upon the predicted settlement and its effect on structure and significance.

7.5.22 Listed bridges, viaducts and other structures have been assessed differently due to their differing structural forms and the fact that their structures in many respects do not adhere to the model as developed by Burland *et al* (1995)[27]. Bridges and associated foreshore structures have been subject to both specific structural and heritage significance assessments, and the resulting information used to assess damage to the heritage significance that is expected from ground movement.

7.5.23 For both listed buildings and listed bridges, viaducts and other structures, the assessment of the effects of ground movement on listed buildings and structures is based on the damage risk predicted by the assessment for each listed building or structure.

7.5.24 As per the overall EIA methodology, the asset significance of the receptor (for, example, high in the case of a Grade I listed building) and magnitude of impact (ranging from negligible to high) are combined to identify the significance of effect (as detailed in paras. 7.5.36 to 7.5.45 below).

7.5.25 When undertaking each site assessment, consideration has been given to whether there are any common buried or above ground heritage assets that extend into more than one Thames Tideway Tunnel project site and which would be physically affected by development at both sites. However, no common assets have been identified through the assessment process at any of the sites, therefore no site assessments take into account construction activity at other Thames Tideway Tunnel project sites.

Assessment of effects on the setting of heritage assets

7.5.26 The methodology for assessing the setting of heritage assets follows English Heritage guidance (English Heritage, October 2011)[28], and has been applied to above heritage ground assets and known buried heritage assets of high significance.

Above ground heritage assets

7.5.27 The construction phase assessment assesses the effect of construction works, including the presence of construction plant, cranes, hoardings, lighting and related services, on the historic character and setting of heritage assets within the assessment area for each site, as defined in para. 7.5.9. The assessment is based on analysis of the significance of heritage asset and the contribution of setting to that significance and the role of the site in that contribution.

7.5.28 Where a site lies within a conservation area, consideration has been given to the effects on the historic character within the assessment area. Where a site lies adjacent to a conservation area, consideration has been given to the effects on its setting and those of identified assets within the conservation area. In accordance with the *NPS* (Defra, 2012)[29], consideration has been given to the 'relative significance of the element affected and its contribution to the conservation area of World Heritage Site as a whole'.

7.5.29 Adjacent Thames Tideway Tunnel project sites have also been considered to identify the potential for additional effects on the historic character and setting of heritage assets within the assessment area of a given Thames Tideway Tunnel project site, where such receptors may be affected by two or more Thames Tideway Tunnel project sites.

7.5.30 As per the overall EIA methodology, the asset significance of the receptor (for, example, high in the case of a Grade I listed building) and magnitude of impact (ranging from negligible to high) are combined to identify the significance of effect (as detailed in the assessment matrix set out in Vol 2 Table 7.5.2 and paras. 7.5.36 to 7.5.45 below).

7.5.31 It should be noted that the methodology for assessing effects on townscape character is detailed separately in Section 11 Townscape and visual. 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. This is explained in each site volume as required.

Buried heritage assets

7.5.32 With reference to buried heritage assets, the English Heritage guidance states: 'Heritage assets that comprise only buried remains may not be readily appreciated by a casual observer, they nonetheless retain a presence in the landscape and, like other heritage assets, have a setting….While the form of survival of an asset may influence the degree to which its setting contributes to significance and the weight placed on it, it does not necessarily follow that the contribution is nullified if the asset is obscured or not readily visible.'[30]

7.5.33 Impacts resulting from construction of the Thames Tideway Tunnel project are assessed on the setting of known buried heritage assets of high significance. This is in line with the guidance which indicates that the level of assessment should be proportionate to the significance of the assets affected. Therefore, the assessment does not assess effects on the setting of potential or likely assets, as their presence is not known for certain. Across all Thames Tideway Tunnel project sites there are four known buried heritage assets of high significance within the assessment area of each site. These comprise: a potential Mesolithic timber structure at Albert Embankment Foreshore site, which is currently visible on the foreshore at low tide; an early medieval fish trap at Heathwall Pumping Station site, visible at low tide; the remains of a prow of a Roman boat known from archaeological records to be preserved in situ beneath the foreshore at Blackfriars Bridge Foreshore site, and the scheduled buried remains of the Stratford Langthorne Abbey at the Abbey Mills site.

7.5.34 The guidance identifies attributes by which such settings may be defined and assessed. For the Thames Tideway Tunnel project, topography and associated land use, associated assets of a similar date and type, along with the way that the asset is currently experienced, are the main attributes in assessing the contribution of setting to the significance of buried heritage assets.

7.5.35 Likely significant effects on buried settings would arise from physical impacts resulting from construction of temporary or permanent structures, which could for example change the way that the asset is experienced (eg, its foreshore context), or remove associated assets in the immediate vicinity which contribute to the understanding of the asset in terms of group value (eg associated fish traps).

Significance criteria

7.5.36 The level of significance of effects on heritage assets is derived from measures of the magnitude of impact (change) and the sensitivity of the receptors (heritage assets) affected as described below.

7.5.37 Environmental effects may be either adverse or beneficial and are determined in accordance with a topic specific significance matrix presented in Vol 2 Table 7.5.1. Where information is insufficient to be able to quantify the asset significance with any degree of certainty, significance of environmental effect is given as uncertain.

Determining magnitude of impacts

7.5.38 The determination of magnitude of impact (change) upon asset significance is based on the severity of impact on the existing baseline. The assessment uses professional judgement to consider the degree of change to an asset and its significance. Vol 2 Table 7.5.1 below sets out the criteria used to define impact magnitude.

Vol 2 Table 7.5.1 Historic environment – magnitude criteria for impacts

Impact magnitude	Definition
High	Complete removal of asset Change to asset significance resulting in a fundamental change in our ability to understand and appreciate the resource and its historical context, character and setting. The transformation of an asset's setting in a way that fundamentally compromises its ability to be understood or appreciated. The scale of change would be such that it could result in a designated asset being undesignated or having its level of designation lowered.
Medium	Change to asset significance resulting in an appreciable change in our ability to understand and appreciate the asset and its historical context, character and setting. Notable alterations to the setting of an asset that affect our appreciation of it and its significance; or the unrecorded loss of archaeological interest.
Low	Change to asset significance resulting in a small change in our ability to understand and appreciate the asset and its historical context, character and setting.
Negligible	Negligible change or no material change to asset significance. No real change in our ability to understand and appreciate the asset and its historical context, character and setting.

Determining significance of effects

7.5.39 The significance of historic environment effects has been determined by combining the identified impact magnitudes, with the significance of the heritage assets affected by those impacts, as set out in the matrix shown in Vol 2 Table 7.5.2 below.

7.5.40 The matrix includes several variations from the generic matrix presented in Section 3 General EIA methodology.

7.5.41 The value of 'uncertain' is a variation which reflects the buried nature of the archaeological resource which is often unknown. The matrix is intended as a guide to provide transparency in the assessment process. However, it allows flexibility to apply professional judgement depending on the nature of the asset and the impact upon it. Where the environmental effect in the matrix is shown as being either major or moderate, or moderate or minor the significance of effect has been identified through professional judgement. For example, where a high magnitude of impact is only likely to affect certain localised areas it may be appropriate to judge that the significance of effect is moderate rather than major.

7.5.42 Where the likelihood of a particular type of buried heritage asset being present is considered to be low, the probability of the predicted effect occurring is therefore low, and the effect is unlikely in EIA terms.

7.5.43 Red shading in the table denotes a ‘significant’ effect (ie, moderate and major effects) while green shading denotes an effect that is not significant (minor or negligible). Mitigation is proposed, where possible, for all physical effects, including minor adverse effects. This is as per the *NPPF* (Department of Communities and Local Government, 2012)[31] which recognises that heritage assets are an irreplaceable resource and that the level of mitigation should be appropriate to the significance of the heritage asset. It is generally considered as standard practice within the planning system to implement mitigation measures in order to offset any level of adverse effects on a heritage asset. This is to ensure that finite and irreplaceable remains are not removed/lost without record. The level of mitigation proposed is, in each case, proportionate to the significance of the asset being affected. For example, measures to offset a minor adverse effect would typically comprise a basic archaeological record through an archaeological watching brief, or a basic standing building survey for minor adverse effects on above ground assets.

7.5.44 In terms of effects on the character, setting and appearance of heritage assets, mitigation is required for significant adverse effects. However, in general no mitigation is possible beyond those measures embedded in the proposed development, including the CoCP and design principles.

Vol 2 Table 7.5.2 Historic environment – significance of effect criteria

Impact magnitude	Asset significance (receptor value/sensitivity)				
	High	Medium	Low	Negligible	Uncertain
High	Major – beneficial or adverse	Major/Moderate*– beneficial or adverse	Moderate*– beneficial or adverse	Negligible	Uncertain
			Minor*– beneficial or adverse		
Medium	Major/Moderate*– beneficial or adverse	Moderate– beneficial or adverse	Minor– beneficial or adverse	Negligible	Uncertain
Low	Moderate– beneficial or adverse	Minor– beneficial or adverse	Minor– beneficial or adverse	Negligible	Uncertain
	Minor*– beneficial or adverse				
Negligible	Minor– beneficial or adverse	Negligible	Negligible	Negligible	Uncertain

** Where the environmental effect is shown as major/moderate or moderate/minor the significance of effect has been identified through professional judgement.*

7.5.45 Vol 2 Table 7.5.3 below defines each significance rating. Major and moderate effects are considered to be significant.

Vol 2 Table 7.5.3 Historic environment – significance criteria

Significance of effect	Description
Major adverse	Substantial harm to, or loss of, an asset's significance as a result of changes to its physical form or setting
Moderate adverse	Less than substantial harm to an asset's significance as a result of changes to its physical form or setting
Minor adverse	Limited harm to an asset's significance as a result of changes to its physical form or setting
Negligible	No appreciable change to an asset's significance
Uncertain	Significance of effect uncertain due to lack of information on buried heritage asset significance
Minor beneficial	Limited improvement of an asset's significance as a result of changes to its physical form or setting
Moderate beneficial	Notable enhancement of an asset's significance as a result of changes to its physical form or setting
Major beneficial	Substantial enhancement of an asset's significance as a result of changes to its physical form or setting

7.5.46 Vol 2 Table 7.5.4 below summarises, on a site-by-site basis, the assessments of construction effects undertaken for the historic environment.

Vol 2 Table 7.5.4 Historic environment – construction assessment of sites

	Physical effects			Effects on character and setting	
	Buried assets	Above ground assets	Effects of ground movement	Buried assets	Above ground assets
Acton Storm Tanks	✓	✓			
Hammersmith Pumping Station	✓	✓			✓
Barn Elms	✓	✓			
Putney Embankment Foreshore	✓	✓	✓		✓
Dormay Street	✓	✓			✓
King George's Park	✓	✓			
Carnwath Road Riverside	✓	✓			✓

	Physical effects			Effects on character and setting	
	Buried assets	**Above ground assets**	**Effects of ground movement**	**Buried assets**	**Above ground assets**
Falconbrook Pumping Station	✓	✓			
Cremorne Wharf Depot	✓	✓	✓		✓
Chelsea Embankment Foreshore	✓	✓			✓
Kirtling Street	✓	✓			✓
Heathwall Pumping Station	✓	✓		✓	✓
Albert Embankment Foreshore	✓	✓	✓	✓	✓
Victoria Embankment Foreshore	✓	✓	✓		✓
Blackfriars Bridge Foreshore	✓	✓	✓	✓	✓
Shad Thames Pumping Station	✓	✓			✓
Chambers Wharf	✓	✓			✓
King Edward Memorial Park Foreshore	✓	✓	✓		✓
Earl Pumping Station	✓	✓			
Deptford Church Street	✓	✓	✓		✓
Greenwich Pumping Station	✓	✓	✓		✓
Abbey Mills Pumping Station	✓	✓		✓	✓
Beckton Sewage Treatment Works	✓	✓			
Bekesbourne Street	✓	✓			

7.6 Operational effects assessment

7.6.1 This section describes the approach to assessing the effects of operation at each Thames Tideway Tunnel project site. The approach to assessing project-wide effects is detailed in Section 7.8 below.

7.6.2 The operational phase would not involve any activities below ground aside from maintenance confined within the tunnel infrastructure. Furthermore, once operational, scour protection around foreshore structures would prevent scour affecting heritage assets, whilst in the deeper channel where contraction scour may occur it is very unlikely that archaeological remains would be present. Therefore an assessment has not been undertaken of operational effects on buried assets, or their settings.

7.6.3 The operational phase methodology is therefore limited to the effects on the historic character, appearance and setting of above ground heritage assets.

Assessment years

7.6.4 In terms of assessing operational phase effects on the setting of above ground heritage assets, Year 1 of operation has been used. In addition, consideration is given to the extent to which the operational assessment findings of effects on the character, appearance and setting of heritage assets would be likely to vary materially from those assessed should the programme for the Thames Tideway Tunnel project be delayed by approximately one year.

Assessment areas

7.6.5 The assessment area for the operational phase is the same as that for the construction phase, as set out in para.7.5.8. The assessment area for the setting assessment of above ground heritage assets has been defined with reference to the ZTV of Thames Tideway Tunnel project operational sites (generated for the townscape and visual assessment, as described in Section 11 of this volume), using professional judgement to determine which assets could potentially be subject to significant effects.

Methodology

7.6.6 In accordance with the *NPS* (Defra, 2012)[32] *for Waste Water* and *NPPF* (Department of Communities and Local Government, 2012)[33], as for the assessment of construction effects, the approach to assessing operational effects has been to consider the impact of the proposed development on the significance of heritage assets (described in para. 7.5.10 above).

Assessment of physical effects

7.6.7 As stated in para. 7.6.3, physical effects, including those generated by construction induced ground movement, on above ground and buried heritage assets are not considered in the operational phase.

Assessment of effects on the setting of heritage assets

7.6.8 The methodology for assessing effects on the historic character and setting of heritage assets in the operation phase is the same as that for the construction phase, as defined in paras. 7.5.27 to 7.5.30. This is in accordance with the English Heritage guidance on The Setting of Heritage Assets (October 2011)[34].

7.6.9 In relation to the operational phase, the assessment takes into account the effect of Thames Tideway Tunnel project sites on the historic character and setting of heritage assets within the assessment area for each site, as defined in para. 7.5.9. This includes an assessment of the effects of the presence of new structures, landscaping and other associated infrastructure.

7.6.10 The operational phase assessment considers the magnitude of change in relation to setting and its subsequent effect on the significance of the asset. The criteria for the significance of effect are as set out in para. 7.5.36.

7.6.11 Where relevant, works at other nearby Thames Tideway Tunnel project sites have also been considered, to identify the potential for additional effects on the historic character and setting of heritage assets within the assessment area.

Significance criteria

7.6.12 The level of significance of effects on heritage assets is derived from measures of the magnitude of impact (change) and the sensitivity of the receptors (heritage assets). The methodology for assessing the effect of the operational phase on the historic character, appearance and setting of heritage assets is the same as that for the construction phase, as set out in para. 7.5.36.

7.6.13 Vol 2 Table 7.6.1 below summarises, on a site-by-site basis, the assessments of operational effects undertaken for the historic environment.

Vol 2 Table 7.6.1 Historic environment – operation assessment of sites on above ground assets

	Effects on character and setting
Acton Storm Tanks	
Hammersmith Pumping Station	✓
Barn Elms	
Putney Embankment Foreshore	✓
Dormay Street	✓
King George’s Park	
Carnwath Road Riverside	✓
Falconbrook Pumping Station	
Cremorne Wharf Depot	✓
Chelsea Embankment Foreshore	✓
Kirtling Street	✓
Heathwall Pumping Station	✓
Albert Embankment Foreshore	✓

	Effects on character and setting
Victoria Embankment Foreshore	✓
Blackfriars Bridge Foreshore	✓
Shad Thames Pumping Station	✓
Chambers Wharf	✓
King Edward Memorial Park Foreshore	✓
Earl Pumping Station	
Deptford Church Street	✓
Greenwich Pumping Station	✓
Abbey Mills Pumping Station	
Beckton Sewage Treatment Works	
Bekesbourne Street	

7.7 Cumulative effects assessment

7.7.1 The general approach to assessing cumulative effects is described in Section 3 General EIA methodology. The specific approach for the historic environment is described below. The assessment years considered for the cumulative effects assessment remain as defined in para. 7.5.2 to 7.5.5 and 7.6.4 above.

7.7.2 Cumulative effects comprise elevated (ie greater) environmental effects which result from of a combination of the impact of the proposed Thames Tideway Tunnel project development with other non-Thames Tideway Tunnel project developments. The cumulative assessment has been undertaken qualitatively to identify whether an elevated effect would occur, without assigning a particular level of significance.

Construction

Assessment of physical effects

7.7.3 In terms of the historic environment, an elevated, cumulative effect (which could be beneficial or adverse), could occur where Thames Tideway Tunnel project and non-Thames Tideway Tunnel project developments both have a physical impact upon an above ground or buried heritage asset, that is common to both projects. This combined impact could potentially result in an effect that is greater than that of each project when considered individually. The site development schedule for each project site (see Vol 4 to 27 Appendix N) has been reviewed to identify non-Thames Tideway Tunnel project developments immediately adjacent to a Thames Tideway Tunnel project site or which extend into a site, which may have an impact on heritage assets that are common to both projects. Physical cumulative effects on above ground and/or buried heritage have therefore been assessed for the following sites: Hammersmith Pumping

Station, Chambers Wharf, Abbey Mills Pumping Station, and Beckton Sewage Treatment Works.

7.7.4 For the assessment of cumulative effects resulting from damage from ground movement, cumulative effects could occur where Thames Tideway Tunnel construction phase induced ground movement is predicted to cause damage to listed buildings and structures that are also predicted to suffer damage as a result of other schemes. The only site where this may happen is Cremorne Wharf. Therefore no other site assessments include an assessment of cumulative ground movement effects.

Assessment of effects on the setting of heritage assets

7.7.5 In terms of the historic environment, an elevated, cumulative effect (which could be beneficial or adverse), could occur where Thames Tideway Tunnel project and non-Thames Tideway Tunnel project developments both have an impact upon the historic character or setting of above ground or buried heritage assets in the assessment area. A cumulative effect is registered where the combined impact results in an effect that is greater than the project development when considered individually.

7.7.6 The site development schedule for each project site (see Vol 4 to 27 Appendix N) has been reviewed to identify non-Thames Tideway Tunnel project developments which may have an impact on heritage assets that are common to both projects. Consideration has been given to the relative distance of development schemes to each project site and the potential for screening by the intervening presence of other buildings and mature vegetation. Those that would have no effect have been excluded from the assessment. No cumulative effects on the setting of known buried heritage assets of high significance have been identified. Cumulative effects on above ground heritage have been assessed for the following sites: Cremorne Wharf Depot, Chelsea Embankment Foreshore, Kirtling Street, Heathwall Pumping Station and Chambers Wharf.

Operation

7.7.7 Consideration of the potential for cumulative effects on the historic character and setting of above ground heritage assets follows the same methodology as for the construction phase as set out in para. 7.7.5. Cumulative effects on above ground heritage have therefore been assessed for the following sites: Hammersmith Pumping Station, Chelsea Embankment Foreshore, Kirtling Street, Heathwall Pumping Station, Chambers Wharf and Deptford Church Street.

7.8 Project-wide effects assessment

7.8.1 The general approach to assessing the likely significant effects, including project-wide effects, is described in Section 3. The specific approach for assessing project-wide historic environment effects is described below.

7.8.2 Project-wide effects on heritage assets comprise the potential impact of ground settlement associated with the main Thames Tideway Tunnel and connection tunnels on statutorily listed buildings and structures and scheduled monuments during the construction and operational phase.

However, as ground movement is induced by construction activities, effects are only considered in the construction phase. Ground settlement is the slight sinking of existing ground level following the construction of deep underground structures such as the main tunnel and connecting tunnels, which can sometimes lead to structural damage or damage to significant finishes in buildings.

Assessment years

7.8.3 No specific assessment year has been identified for ground movement effects as although most ground movement generally happens during or soon after the works causing ground movement take place, ground movement generally continues for some years afterwards. Ground movement is likely to commence when demolitions and excavations begin. As all ground movement would be generated by construction activities, the project-wide ground movement assessment therefore encompasses the whole construction phase.

Assessment areas

7.8.4 The assessment area to assess the effects of ground movement induced by the Thames Tideway Tunnel project works is defined by the area within which ground movement of 1mm or more is predicted. Twenty five listed buildings, 18 listed bridges and viaducts, and one wall have been identified within this assessment area. One scheduled monument, the remains of King Edward's moated medieval manor house, falls partly within this area, although it would not be affected by ground movement.

Methodology

7.8.5 The assessment of effects has drawn on modelling undertaken to predict the level of ground movement which may occur, and to understand how this could have an impact upon listed buildings and the need for any protective measures and monitoring.

7.8.6 The methodology is detailed in listed buildings damage assessment report which is appended (see Vol 2 Appendix E.3). It has involved the following stages:

a. Identification of the geology and the response of strata to tunnelling and shaft excavation.

b. Review of tunnelling methodology and prediction of resulting ground movement.

c. Assessment of structural sensitivity, heritage sensitivity and current building condition through desk-based assessment and site survey.

d. Prediction of the damage category, ranging from negligible to very severe.

e. Determination of overall score based on receptor sensitivity (c, above) and damage category (d, above).

f. Prediction of the resultant environmental effect on the significance of listed buildings and structures in accordance with the assessment methodology detailed in Section 7.5 above.

7.9 Assumptions and limitations

7.9.1 This section details general assumptions and limitations associated with the historic environment assessment. Site-specific assumptions and limitations are detailed in Vol 4 to 27 Section 7 Historic environment.

Assumptions

7.9.2 The assessment relies on available data, and best endeavours have been made to ensure that the data are accurate and up to date. It is assumed that information on the GLHER database is accurate. However, whilst compiling the baseline a process of review and validation of the GLHER data has taken place (for example ensuring asset Ordnance Survey national grid references match the asset address, and undertaking further research, where appropriate, into GLHER entries with little information). Data on locally listed buildings has been drawn from the GLHER, which it is assumed would include any buildings locally listed by local authorities.

Limitations

7.9.3 The main limitation to the assessment of effects on buried heritage assets is the nature of the archaeological resource - buried and not visible - which means it can be difficult to predict accurately the presence and likely significance of buried heritage assets, and the impact of the project upon such assets, based primarily on a desk based sources.

7.9.4 The principle sources of information on heritage resources are the GLHER and the LAARC, which list all known archaeological sites and finds. The information listed in the gazetteers within the baseline sections of each site-specific assessment provides an initial indication of assets present rather than a definitive list of all potential archaeological assets because the full extent of a buried heritage resource cannot be known prior to site-specific archaeological field investigation.

7.9.5 The majority of sites have not been subject to archaeological investigation in the past, although information from investigations in the assessment area around many of these sites has helped to build up a picture of the likely potential for buried heritage assets within the site. However, for a small number of sites archaeological understanding is limited due to a lack of past archaeological investigation in the assessment area around the site. Current understanding may therefore be limited, in particular for periods not present or poorly presented in the historical record (prehistoric, Roman and early medieval periods). Therefore, the presence and extent, date, nature, survival and significance of possible, previously unrecorded, buried heritage assets are largely uncertain.

7.9.6 Where information is not available, professional judgement has been used to assess historic environment potential. This approach is based on other relevant data, for example the nature and depth of subsurface geological deposits as noted in geotechnical surveys and BGS data (this can provide an indication of the likely nature, depth, and survival of archaeological remains, if present), and the history of past land use as shown on historic maps (which is useful for determining likely truncation and survival potential). Further site based archaeological field investigation is normally required to clarify archaeological potential and significance.

7.9.7 The absence of information from archaeological investigations also limits the extent to which the contribution of setting to the significance of buried heritage assets can be understood. Professional judgement has been used to estimate the likely setting of an asset and therefore enable an assessment of effects.

7.9.8 Relevant organisations were contacted for information on past dredging within the Thames channel, but no such information was obtained. In order to address this, bathymetric data held by Thames Water has been used to interpret where scour or dredging has occurred.

7.9.9 There has also been little research into the effects of compression on buried heritage assets within foreshore alluvium, and there is no detailed data or formulae that can be applied to the Thames Tideway Tunnel project foreshore sites in order to predict compression effects from the temporary cofferdam fill material. Professional judgement has been used to predict the likely impacts on different material remains within the foreshore.

7.9.10 Notwithstanding these limitations, the methodology is robust, utilising reasonably available information, and conforms to the requirements of local and national guidance and planning policy. Typically, appropriate standard archaeological prospection and evaluation techniques are utilised post-consent to reduce the uncertainties inherent in any desk-based assessment, as part of an overall EIA mitigation strategy.

7.9.11 The ground movement model has predicted the level of settlement likely to be experienced by listed buildings within the zone of construction induced settlement. Where the level of physical damage would permanently damage the significance of heritage assets mitigation has been proposed within the project, and is assessed in the *Environmental Statement*. Lesser damage would be repaired when ground movements have reduced to an acceptable level where the risk of significant damage is no longer present. Although the predictions are conservative by their nature, and the exact nature of physical damage cannot be predicted, damage to significance would be mitigated through the process of repair using standard conservation techniques. Although the vast majority of listed buildings within the 1mm settlement zone have been inspected externally and internally, a number of buildings have not been inspected internally, through lack of access, despite the best efforts of the project to obtain access.

7.10 Mitigation

Construction

7.10.1 The Thames Tideway Tunnel project has been designed to minimise environmental effects and therefore the construction design and methods take account of historic environment considerations, including removal and later reinstatement of some heritage assets during construction, such as listed lamp stands and benches, and measures within Section 12 of *Code of Construction Practice* (*CoCP*) Part A and B (for example to prevent accidental strike damage to structures of historic interest from vehicles and plant). Where such measures form part of the project, they are identified in Vol 1 (for the tunnel itself) and Section 3 Proposed development of Vol 4 to 27 (for each site) and have been considered as embedded measures within the assessment. The *Code of Construction Practice* (*CoCP*) is provided in Vol 1 Appendix A. It contains general requirements (Part A), and site specific requirements (Part B).

7.10.2 Where the assessment indicates significant effects having taken account of embedded measures, mitigation has been identified where possible. It should be noted that measures to mitigate effects on buried heritage, whilst referred to in the *CoCP* in broad terms, would be detailed in the *Site Specific Archaeological Written Scheme of Investigation* (*SSAWSI*), in line with the *Overarching Archaeological Written Scheme of Investigation (OAWSI)*, and would be subject to the findings of field evaluation, and are therefore reported as mitigation. This approach is described further in paras 7.10.4 to 7.10.9 below.

Buried heritage assets

7.10.3 As per the NPS, (para 4.10.19)[35], 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.

7.10.4 For the purposes of the assessment an indication of mitigation is presented, which for buried heritage assets would be further refined following field evaluation. Field evaluation could include a variety of techniques, such as geotechnical investigation, foreshore survey and monitoring, geoarchaeological deposit modelling, archaeological test pits and trial trenches, detailed standing building survey and inspection, foreshore survey (including metal detector and finds collection surveys), and side scan sonar survey (for areas permanently submerged).

7.10.5 Mitigation of adverse effects may include preservation in situ or archaeological investigation (preservation by record).

7.10.6 Preservation *in situ* is normally the preferred option for known assets of particularly high (ie, national or international) significance, where feasible. However in certain circumstances, for example parts of the foreshore where active scouring is taking place, it may be preferable to undertake a programme of archaeological investigation to mitigate the loss of an asset which would otherwise occur naturally. No assets warranting preservation in situ have been identified at any Thames Tideway Tunnel project site.

7.10.7 The mitigation strategy for buried heritage assets is therefore archaeological investigation, recording and dissemination at a level appropriate to the significance of the asset. This would ensure that asset significance (in terms of evidential and historical value) is preserved even when an asset has been physically removed.

7.10.8 Investigation techniques could include open area or targeted archaeological excavation, and/or an archaeological watching brief (for remains of lesser significance), geoarchaeological deposit modelling and palaeoenvironmental sampling. The results (including site notes, plans and finds etc.) would be deposited in the Museum of London Archaeological Archive. The findings would be disseminated at a level appropriate to their significance. This could range from a grey literature report (ie material which is not widely/commercially published, eg archaeological assessment and evaluation reports) deposited with the GLHER, publication in a local archaeological/historical journal, to a monograph or book for important discoveries.

7.10.9 Further details of the likely mitigation measures, and how these would be further defined through subsequent stages of work, is detailed in the *OAWSI* included within Vol 2 Appendix E.2. The *OAWSI* includes an archaeological research framework, which identifies key themes and their objectives that are considered to be of greatest importance for our understanding of the historic environment across the entire Thames Tideway Tunnel project.

Above ground heritage assets

7.10.10 As with buried heritage assets, preservation in situ is the preferred option for assets of high significance (listed buildings and scheduled monuments). Where preservation in situ is not feasible, for example where sections of listed river wall would be partly removed, and for above ground assets of lesser significance, preservation by record is proposed. This would take the form of standing building archaeological survey and recording to an appropriate English Heritage standard[36]. The proposed development also includes policies and principles for the reuse of materials of historic significance.

7.10.11 There are four levels of archaeological record survey for above ground heritage assets, ranging from a basic visual record (Level 1), through to a comprehensive analytical record (Level 4). This would be undertaken prior to the demolition, alteration, or modification of the asset to allow the asset a new function as part of the proposed development.

7.10.12 Mitigation for damage to listed buildings, including buildings, bridges, viaducts and, river walls predicted from ground movement generated by tunneling, demolition and construction work, depends on the nature of the building or structure and the damage risk predicted. All listed buildings within the 1mm settlement contour would be monitored by the installation of monitoring equipment, designed to be sensitive to the significance of the heritage asset. The monitoring would ensure that ground movement, and therefore any resulting damage is as predicted in the assessment. It would also provide an indication if acceptable movement would be exceeded. If there is a danger that it would, predetermined mitigation measures or procedures would be implemented. This may range from limiting ground movement at source to the installation of intrusive protection. The need to preserve the significance of the building and its sensitivity would be a factor in designing the measures.

7.10.13 Following the period of settlement, monitoring equipment would be removed from the listed buildings and any damage resulting from the installation of equipment or from ground movement made good using standard conservation techniques and materials to match those existing.

7.10.14 In terms of mitigating effects on the character and setting of above ground assets, the Thames Tideway Tunnel project has been designed to minimise environmental effects and therefore the design takes account of historic environment considerations including the historic character and setting of above ground heritage assets. Where such measures form part of the project, they are identified in Vol 1 (for the tunnel) and Section 3 of Vols 4 to 27 (for each site) and have been considered as embedded environmental design within the assessment. In general, further mitigation is not possible due to the open and highly visible nature of the construction works. No mitigation is therefore proposed at sites registering significant adverse effects on the historic character and setting of above ground heritage assets as it is not considered possible to further reduce effects over and above through the environmental design measures embedded in the project, which have been developed to mitigate potential adverse effects on the historic environment.

Operation

7.10.15 The Thames Tideway Tunnel project has been designed to minimise environmental effects and therefore the design takes account of historic environment considerations including the setting of above ground heritage assets. Where such measures form part of the project, they are identified in Vol 1 (for the tunnel) and 3 of Vols 4 to 27 (for each site) and have been considered as embedded environmental design within the assessment. No additional mitigation is therefore proposed at sites registering significant adverse effects on the historic character and setting of above ground heritage assets as it is not possible to further reduce effects over and above through the environmental design measures embedded in the project.

7.11 Residual effects assessment

7.11.1 Where mitigation measures are proposed, residual effects are assessed by considering the effectiveness of mitigation in reducing any adverse effects identified. In most cases the strategy would be designed to remove adverse effects entirely, with the result that no residual effects are anticipated.

7.11.2 In some cases, a strategy of preservation by record may reduce, but not offset entirely an adverse effect, and a residual effect would remain. For example, where a listed building is modified permanently because of the requirements of the project, archaeological standing building recording might enhance public appreciation of the significance of an asset, but would not completely mitigate its loss.

7.11.3 Where no mitigation measures are proposed, the residual effects remain as identified through the relevant assessment (construction, operation or project-wide).

References

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

[2] Department of Environment, Food and Rural Affairs (2012). See citation above

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

[4] Greater London Authority, *The London Plan. Spatial Development Strategy for Greater London* (July 2011).

[5] English Heritage. *Conservation principles, policies and guidance*. Swindon (2008)

[6] English Heritage, *The setting of heritage assets* (October 2011).

[7] English Heritage, *Understanding historic buildings: a guide to good recording practice*. Swindon (2006).

[8] Department for Communities and Local Government & Department for Culture, Media and Sport. *Revisions to principles of selection for listed buildings* (March 2007)

[9] English Heritage, *Guidance on conservation area appraisals* (2006)

[10] English Heritage, *Guidance on the management of conservation areas* (2006)

[11] Mayor of London, *London's World Heritage Sites Supplementary Planning Guidance* (March 2012)

[12] 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)

[13] Institute for Archaeologists, *By-laws, standards and policy statements of the Institute of Field Archaeologists, standard and guidance: desk-based assessment*, rev, Reading (2001)

[14] Greater London Archaeology Advisory Service, *Standards for Archaeological Work London Region, External Consultation* (2009)

[15] Corporation of London Department of Planning and Transportation, *Planning Advice Note 3: Archaeology in the City of London, Archaeology Guidance* (2004)

[16] Museum of London and English Heritage, *A research framework for London archaeology*, London (2002)

[17] English Heritage, Essex County Council, Kent County Council, Thames Estuary Partnerships, *Greater Thames Estuary Historic Environment Research Framework* (2010)

[18] English Heritage. *Conservation principles, policies and guidance*. Swindon (2008).

[19] Department of Environment, Food and Rural Affairs (2012). See citation above.

[20] Communities and Local Government (March 2012). See citation above.

[21] Shilston DT and Fletcher SL 'Geotechnical engineering for the in situ preservation of archaeological remains'. In M. Corfield, P. Hinton, T. Nixon, and M. Pollard (eds), *Preserving Archaeological Remains In Situ: Proceedings of the Conference of 1st–3rd April 1996*, p9. London: Museum of London Archaeology Service (1996).

[22] Sidell EJ, Higuchi T, Allson RL and Long AJ 'The response of archaeological sediments and artefacts to imposed stress regimes as a consequence of past, present and future anthropogenic activity'. In T. Nixon (ed.), *Preserving Archaeological Remains In Situ: Proceedings of the Conference of 12–14 September 2001*, p47. London: Museum of London Archaeology Service. (2004)

[23] Shilston DT and Fletcher SL 'Geotechnical engineering for the in situ preservation of archaeological remains'. In M. Corfield, P. Hinton, T. Nixon, and M. Pollard (eds), Preserving Archaeological Remains

In Situ: Proceedings of the Conference of 1st–3rd April 1996, p9. London: Museum of London Archaeology Service (1996).

[24] de Beer, H. and Matthiesen, H. *Groundwater monitoring and modelling from an archaeological perspective: possibilities and challenges.* Geological Survey of Norway Special Publication 11, 67–81 (2008)

[25] Hopkins, D 'Even the ancient was once young: lessons about biodegradation from the Wareham (Dorset) experimental earthwork'. In T. Nixon (ed.), *Preserving Archaeological Remains In Situ: Proceedings of the Conference of 12–14 September 2001*, p63. London: Museum of London Archaeology Service (2004).

[26] Burland J B (1995). Assessment of risk of damage to buildings due to tunnelling and excavations. Invited Special Lecture to IS-Tokyo '95: *1st Int. Conf. on Earthquake Geotechnical Engineering*,

[27] Burland J B (1995). Assessment of risk of damage to buildings due to tunnelling and excavations. Invited Special Lecture to IS-Tokyo '95: *1st Int. Conf. on Earthquake Geotechnical Engineering*

[28] English Heritage, *The setting of heritage assets* (October 2011).

[29] Department of Environment, Food and Rural Affairs (2012). See citation above

[30] English Heritage, *The setting of heritage assets*, 8 (October 2011).

[31] Communities and Local Government (March 2012). See citation above.

[32] Department of Environment, Food and Rural Affairs (2012). See citation above.

[33] Communities and Local Government (March 2012). See citation above.

[34] English Heritage, *The setting of heritage assets* (October 2011)

[35] Department of Environment, Food and Rural Affairs (Defra)*. National Policy Statement for Waste Water 2012*, para 4.10.19.

[36] 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

Doc Ref: **6.2.02**

Volume 2: Environmental assessment methodology

Section 8: Land quality

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

Hard copy available in

Box **16** Folder **A**
January 2013

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

This page is intentionally blank

Thames Tideway Tunnel

Environmental Statement

Volume 2: Environmental assessment methodology

Section 8: Land quality

List of contents

Page number

List of tables

Page number

This page is intentionally blank

8 Land quality

8.1 Introduction

8.1.1 This section sets out the methodology for assessing the likely significant effects of the Thames Tideway Tunnel project on land quality. The methodology outlined in this section has been applied to all sites, unless otherwise indicated in the site assessment volumes.

8.1.2 The topic specific methodology presented in this section builds upon the general assessment methodology summarised in Section 3 of this volume and develops this to take account of the range of likely significant environmental effects of land quality arising from the construction of the project.

8.1.3 The need for the assessment of land quality effects results from the potential for the project to encounter land contamination in below ground construction related activities.

8.1.4 Land can become contaminated by previous industrial uses through activities that may result in the spillage and seepages of harmful substances.

8.1.5 Contaminated land may be encountered, disturbed and exposed where construction works for the Thames Tideway Tunnel project involve excavation, for example the construction of shafts and associated interception works or for the excavation of utilities or during demolition works.

8.1.6 Such contamination has the potential to adversely affect site end users, off-site receptors (neighbouring properties and people) and the built environment) if it is not addressed, managed and remediated where necessary.

8.1.7 Contamination can also potentially impact upon water resources and ecology via mobilisation of pre-existing contamination, creation of new contaminant pathways and the addition of new pollution sources through construction of the project.

8.1.8 Impacts to these receptors from land quality are considered and assessed within their respective topic sections where necessary. The following topic methodologies should therefore also be referred to, in order to gain a wider understanding of impacts arising from land quality:

a. Section 5 Ecology – aquatic

b. Section 6 Ecology – terrestrial

c. Section 13 Water resources – groundwater

d. Section 14 Water resources – surface water

8.1.9 The land quality assessment considers soil based contamination as well as the human health risk from perched water[i] or contaminated groundwater (which may occur via direct contact or vapour migration pathways). Groundwater contamination of designated aquifers is specifically excluded from the land quality assessment as it is covered in Section 13 of this volume.

8.1.10 The land quality assessment considers the likely significant effects associated with the migration of contaminated dust and vapours to offsite receptors during construction. The methodology for assessing the likely significant effects of all dust, and in some cases vapour (which manifests as odour), are presented in Section 4 Air quality and odour of this volume.

8.1.11 Impacts and effects associated with the mobilisation of potentially contaminated river sediments which may affect ecological receptors or water quality are considered in Section 5 and Section 14 of this volume.

8.1.12 Impacts and effects associated with invasive species are considered in the land quality assessment in relation to impacts to the built environment as unchecked growth of this plant can damage structures. For wider guidance on Japanese knotweed, its control reference should be made to the *Code of Construction Practice (CoCP)*, in particular Section 9 on land quality. The *CoCP* is provided in Vol 1 Appendix A. It contains general requirements (Part A), and site specific requirements (Part B).

8.1.13 Contaminated and uncontaminated soils from excavations would be handled and managed in accordance with the project *Excavated material and waste strategy* and *CoCP* Part A and B, in particular Section 9.

8.1.14 Operational land quality effects are considered unlikely and have therefore not been assessed. This is on the basis that the embedded measures adopted during construction (isolation or remediation) would remove previously existing contamination.

8.1.15 Due to the localised nature of land quality effects no project-wide effects are likely for land quality and therefore this has not been assessed (See Vol 3 Section 8).This was set out in the *Scoping Report* and no stakeholder comments were received.

8.2 Engagement

8.2.1 The general approach adopted regarding engagement is summarised in Section 2 of this volume.

8.2.2 Engagement with statutory consultees has been undertaken through a programme of briefings, presentations, technical working groups and workshops as well as a position paper on land quality and through scoping on the environmental impact assessment (EIA) *Scoping Report* and the phase two consultation. The IPC provided comments on the *Scoping*

[i] Perched Water is water supported by low permeability layer above main saturated zone (adapted from EA (2008) Groundwater policy and practice).

Report which are included in Vol 2 Appendix A.3 and which have been addressed in this *Environmental Statement*.

8.2.3 The engagement process is summarised below with further information included in Vol 2 Appendix F.1:

a. The proposed land quality approach was presented at the Environmental Health Officer (EHO) Forums in November 2010 and December 2010. Each local authority was invited to send representatives to the forum to discuss the scope of the land quality assessments. Discussions relating to the measures to be incorporated into the *CoCP* were also held at these meetings.

b. Between November 2010 and April 2011 requests were issued to all local authorities directly impacted by the scheme to provide any information held in relation to contaminated land within a defined search area (a 250m buffer around each site). Relevant information provided by the local authorities, is presented within baseline reports for the individual site assessments (see Section 8.4 in Vol 4 to 27). Such information typically included:

i records of entries in their Part IIA Contaminated Land register[ii]

ii site investigation reports

iii records of remediation schemes

iv remediation validation reports.

c. Technical working groups (TWG) have been held with the Environment Agency (EA) on four separate occasions (March 2011, February 2012, May 2012, September 2012) to discuss and agree the approach to land quality assessment, including the requirements for the assessment of operational effects and also the interface with the assessment of water resources.

8.2.4 Site-specific comments contained within the scoping opinions in relation to land quality are reported in each site assessment volume (see Section 8.2 in Vol 4 to 27).

8.2.5 The London Boroughs (LB) made the following suggestions via the EHO forum and via the *Scoping Report*:

a. land quality should be considered at depth within undisturbed soils

b. The *Environmental Statement* should consider the potential impacts of soil contaminants on sensitive receptors beyond the development site boundary.

8.2.6 Both of these points have been addressed in the *Environmental Statement* for all sites. Land quality has been considered for all sites to the full shaft depth. The groundwater project-wide assessment (see Section 13 of Vol 3) considers the effects of contamination at depth to tunnelling. The *CoCP*

[ii] Part IIA of the Environmental Protection Act (EPA) 1990 and the Contaminated Land (England) Regulations 2000, require all local authorities to maintain a public register of land that has been statutorily determined as 'Contaminated Land' within their borough.

Part A and B (Section 9) and the *Excavated material and waste strategy* include details on handling of excavated soils. In addition, the land quality methodology includes the assessment of the potential impacts of soil contaminants on sensitive receptors beyond the development site boundary.

8.2.7 In response to the *Scoping Report* the EA indicated that the land quality topic should consider the operational phase as leakage may lead to land contamination and new pathways being created. In a subsequent TWG meeting on 4th May 2012, with the EA it was agreed that the operational effects could be scoped out and not assessed as seepage to and from the shafts and tunnels are assessed as part of the groundwater assessment. In addition, it should be noted that the effects of any seepage from the shaft have been assessed as part of the water resources – groundwater section.

8.2.8 Details of phase two consultation responses can be found in Vol 2 Appendix F.1. One response from the London Borough of Tower Hamlets was provided on the approach to desk based data gathering. The suggestions would be applied through the *CoCP*. The remaining phase two consolation responses are site specific and have been addressed in the appropriate site assessments.

8.2.9 The points raised during this engagement have been considered in the development of the land quality methodology presented below.

8.3 Legislation and guidance

8.3.1 There is no industry-wide accepted methodology for the assessment of land quality for the purposes of an EIA. The EA does however provide guidance on EIA with regard to contamination issues (EA, 2002)[1] which has formed the basis of this methodology.

8.3.2 The following legislation and guidance has also been considered in developing the land quality EIA methodology:

a. Investigation of potentially contaminated sites: *Code of practice* (British Standards Institute, 2011)[2].

b. *Contaminated Land Risk Assessment– A guide to good practice* (C552) (CIRIA, 2001)[3].

c. *The EA and Water Framework Directive classifications for surface water* (European Union, 2000)[4].

d. The EA classification scheme for protection of groundwater resources that defines Source Protection Zones (SPZs) (EA, 2012)[5]

e. *The Environmental Protection Act 1990*[6].

f. CLR11 – *Model Procedures for the Management of Land Contamination* (EA, 2009)[7], that assists both local authorities and practitioners in:

i assessing the degree to which land is contaminated ii deciding whether such land is contaminated within the definition of Part IIA of the Environmental Protection Act 1990 (as amended by the Water Act 2003) and revised statutory guidance (Defra, 2012)[8]

iii providing a framework to allow brownfield sites to be brought back into beneficial use.

g. EA *Soil Guideline Values* (for the assessment of risks to human health)[9].

h. Other widely used UK specific human health risk assessment criteria (Land Quality Management/Chartered Institute of Environmental Health)[10], (CLAIRE, 2010)[11].

8.3.3 This guidance material has also helped inform the measures relating to land quality and land remediation within Section 9 of the *CoCP* Part A and B which represents the embedded design measures for the project.

8.3.4 The methodology has also been tailored around the legislation and guidance detailed above to ensure that the land quality assessment meets the requirements of the *Infrastructure Planning (Environmental Impact Assessment) Regulations 2009*[12] which specifically require a description of the aspects of the environment likely to be significantly affected by the development, including, those re*levant to contaminated land such as population, fauna, flora, soil, water,* air, and material assets and the interrelationship between the above factors.

8.3.5 Vol 2 Table 8.3.1 presents the requirements within the NPS relevant to land quality and explains how the requirements have been addressed within the *Environmental Statement*. The table also gives the location of the relevant material. The requirements within the NPS can be found in Section 4.8 of the NPS.

Vol 2 Table 8.3.1 Land quality – requirements of the NPS and how they have been addressed

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
The applicant should seek to minimise impacts on the best and most versatile agricultural land (defined as land in grades 1, 2 and 3a of the Agricultural Land Classification), and preferably use land in areas of poorer quality (grades 3b, 4 and 5) except where this would be inconsistent with other sustainability considerations. **The decision maker** should ensure that justification is provided where applicants site their scheme on best and most versatile agricultural land.	The Thames Tideway Tunnel project would be within an urban area and would therefore not impact Agricultural Land.	This has been scoped out of this assessment.
Applicants should also identify any effects and seek to minimise impacts on soil quality taking into account any mitigation measures proposed.	Measures to protect soil quality have are described in Section 9 of Part A of the *CoCP*.	Measures to protect soil quality are included within the *CoCP* Part A Section 9.
The applicant should ensure that they have considered the risk posed by land contamination for developments on previously developed land.	The land quality topic identifies potentially contaminating land uses at and within the vicinity of each site from a review of a wide range of data sets. These data sets are those that are interrogated as part of a preliminary contamination risk assessment which is the first step in assessing land contamination potential and	This section on methodology and each land quality Vol 4 – 27 Section 8 and Section 9 of the *CoCP* Part A and B.

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
	management options under both BS10175:2011, Redevelopment of potentially contaminated sites: Code of practice and CLR11: Model procedures for the management of land contamination. In addition the topic considers a conceptual site model at each site to look at interactions. Impacts to the various receptors are reported in the pertinent topic (and are split across air quality and odour, water resources (groundwater and surface water) and aquatic ecology. Additionally a number of measures are contained in Section 9 of Part A of the *CoCP* which require contractors to follow the regulatory best practice in respect to land contamination ensuring that sites are fit for purpose in the completed project.	

8.4 Baseline data collection

8.4.1 The land quality baseline has been established through desk based study (including review of ground investigation data), and field survey (comprising walkover surveys and sediment sampling).

8.4.2 A baseline report has been compiled for each project site. The baseline reports are summarised in the site assessments in Section 8.4 in Vol 4 to 27 and comprise details of a site walkover, review of historic contamination sources, unexploded ordnance, Thames Tideway Tunnel project ground investigation data as well as third party ground investigation data.

8.4.3 The following sections outline the methodology for collecting baseline data for the land quality site assessments.

Desk based baseline data

8.4.4 The method for determining and appraising baseline conditions involves the collection and interpretation of desk based baseline data. Information presented in Vol 2 Table 8.4.1 has been collected and reviewed and used to inform subsequent survey work.

Vol 2 Table 8.4.1 Land quality – desk based baseline data sources

Source	Data
Landmark Information Group	Historic maps
	Source Protection Zones
	Pollution incidents to controlled waters
	British Geological Survey (BGS) boreholes
	Historic landfill sites
	Registered landfill sites (point)
	Licensed waste management facilities (point)
	Licensed waste management facilities/landfill boundaries
	Registered waste treatment or disposal sites
	Control of major accident hazards (COMAH) sites
	Integrated pollution permit and control (IPPC) permit sites (active)
	Registered radioactive substances
	Authorised radioactive substances
	Notification of installations handling hazardous substances (NIHHS)
	Past contamination - land use
	Groundwater abstraction points
Thames Water (operations)	Review of Thames Water operational site records to establish list of potentially contaminating substances stored on site and whether or not any pollution incidents had taken place over the previous five years
6 Alpha	Unexploded ordnance surveys
Health Protection Agency	Indicative atlas of radon in England and Wales
Local authorities	Contaminated land database

Source	Data
Project wide ground investigations	Site specific data on geology, soil, soil gas and groundwater.

Soil quality assessment criteria

8.4.5 In order to provide an assessment of the levels of contamination present, soil quality data from the preliminary geotechnical baseline ground investigations (some of which would be classed as field survey baseline data) and existing site investigation data have been compared to widely used UK specific assessment criteria, namely:

a. *Soil Guidance Values* (SGV) published by the EA (Defra/EA, 2010)[13].

b. *Generic assessment criteria* (GAC) published by the Chartered Institute of Environmental Health and Land Quality Management (2nd Edition)[14].

c. Generic assessment criteria published by Contaminated Land: Application in Real Environments (CLAIRE, 2010)[15].

8.4.6 For the purpose of this assessment, the data have been compared to industrial/commercial assessment criteria. These assessment criteria provide generic screening values to assess the potential for the long term risks to human health.

8.4.7 As the screening values are likely to be conservative (as they are for industrial/commercial end uses) for several applications, such as parks, data has also been compared to more stringent residential assessment criteria in areas that are currently used as soft landscaped recreation areas (such as King Georges Park, Barn Elms, King Edward Memorial Park Foreshore and Deptford Church Street). For reference the SGVs and CLAIRE GACs for various land uses are given in Appendix F.3.

Field survey baseline data

Walkover surveys

8.4.8 A walkover survey of each site was undertaken during 2011 by a land quality specialist. The methodology for the walkover surveys followed widely used guidance on the preliminary assessment of land contamination contained within BS1075: Investigation of Potentially Contaminated Sites (British Standards Institute, 2011)[16].

8.4.9 The aim of the walkover survey was to inspect the condition of the site and surrounding areas in order to identify evidence of historic or ongoing contamination sources, as well as any nearby sensitive receptors. The following data have been collected during the walkover surveys:

a. size and topography of the site and its surroundings

b. neighbouring site land use

c. site buildings – extent and construction types

d. surfacing – extent, type and condition

e. vegetation – type, distribution and signs of distress as well as presence of invasive species

f. presence of fuels or chemicals storage on site and extent and type of containment measures present

g. vehicle servicing or refuelling facilities onsite

h. waste generated/stored onsite

i. surface water bodies

j. site drainage

k. evidence of previous site investigations

l. evidence of land contamination (eg, odours or staining of ground surface).

Site investigation

8.4.10 The project has undertaken a suite of preliminary geotechnical baseline investigations at all of the Thames Tideway Tunnel project sites. The criteria against which this data has been compared is described in para. 8.4.5.

Sediment quality data collection

8.4.11 As part of the field survey baseline data collection a programme of sediment quality analysis was performed at selected foreshore sites.

8.4.12 Sampling of sediments exposed on the River Thames and Deptford Creek foreshores was undertaken by the Port of London Authority (PLA) Hydrographic Department in December 2011 and January 2012 (PLA, 2011)[17] at the following locations:

a. Putney Embankment Foreshore

b. Carnwath Road Riverside

c. Chambers Wharf

d. Chelsea Embankment Foreshore

e. Heathwall Pumping Station

f. Greenwich Pumping Station (Deptford Creek)

g. Victoria Embankment Foreshore.

8.4.13 The sites were chosen as there is the potential for disturbance or excavation of these sediments during the proposed construction works associated with the Thames Tideway Tunnel project. Not all sites where there is the potential for disturbance during construction were sampled, because the selected sites, in addition to the information already gained from other intrusive investigations, were considered to give an appropriate picture of sediment quality.

8.4.14 Between three and five samples of sediment retrieved from the foreshore at each of the seven locations were tested for a wide suite of common contaminants. The range of determinands chosen reflected the wide range of industries formerly present along the river as well as the sewage outfalls that are present.

8.4.15 The results of the laboratory testing were compared against four sets of assessment criteria:

a. a set of criteria that can determine possible risks to aquatic organisms (Canadian Council for the Environment, 2012)[18]

b. a set of criteria used to determine risk to human health (Defra/EA, 2012)[19,20,](CLAIRE, 2010)[21]

c. a set of criteria to judge whether levels of total coliforms are elevated[22]

d. criteria for determining waste classification (EA, SEPA and NIEA, 2011)[23].

8.4.16 In addition, shallow samples of soils/sediments from the project ground investigation within the River Thames were also assessed against the above criteria where available.

All results are reported in the *Sediment Sampling Report (*see Vol 2 Appendix F.2).

Receptor identification and sensitivity

8.4.17 The sensitivity of a receptor, with regards to land quality, relates to the anticipated exposure of the receptor to elevated levels of contamination. As stated above, there are no nationally agreed criteria for determining the value or sensitivity of land quality receptors. The categories provided in Vol 2 Table 8.4.2 below are based on standards and targets set by statutory bodies such as Natural England and the EA, and advisory bodies such as CIRIA.

Vol 2 Table 8.4.2 Land quality – receptor sensitivity criteria

Receptor	Value and/or sensitivity		
	Low	Medium	High
Future users	Industrial, infrastructure (such as Thames Tideway Tunnel project sites), warehouses, car parks, commercial, hard landscaped open spaces	Forestry, agricultural, soft landscaped open spaces	Residential, allotments, school ground
Surrounding land users	Industrial warehouses, car parks, commercial (eg, offices)	Parks and recreation grounds, public open spaces	Residential, allotments, schools
Construction workers or site operatives	Construction workers involved in full-time below	Construction workers involved in limited below	Construction workers or other site staff

Receptor	Value and/or sensitivity		
	ground works or close contact with potentially contaminated materials	ground works or contact with potentially contaminated materials	not involved in contact with contaminated materials (eg office staff or delivery drivers)
Built environment	Infrastructure (eg, roads railways, river walls)	Sites with a local or district value or interest for education or cultural appreciation; locally listed buildings	Sites of national and international importance; World Heritage Sites; Scheduled Monuments

Base case

8.4.18 For land quality, the assessment of construction effects is based on the conditions which are likely to be experienced at the commencement of the construction phase at a particular site (Site Year 1 of construction).

8.4.19 The base case takes into account other developments that are proposed to be built and operational during construction of the Thames Tideway Tunnel project, within a 250m assessment area (chosen as a precautionary distance which would identify all effects), and their potential to introduce new sensitive receptors or contamination pathways. These developments are set out in the site development schedules in Vol 4 to 27 Appendix N for each site volume.

8.4.20 Land quality baseline conditions may have changed from the current baseline conditions by the time the construction phase commences. This is due to the requirement for pre-construction assessment and potential remediation of land contamination that forms part of the proposed development (refer to Section 9 of the *CoCP* Part A and B).

8.4.21 For the purpose of this assessment it has been assumed that contamination that poses an immediate and unacceptable risk to receptors as well as any contamination that may hinder the construction programme, would have been remediated prior to the commencement of the shaft and main tunnel construction works (and in other areas of proposed excavation where necessary). This assumption is for sites where pre-construction assessment identifies the need for site-specific remediation.

8.4.22 Such contamination would include contaminants which may pose an ongoing health risk (eg, materials present at the ground surface that contain asbestos) or a secondary risk to the environment or offsite receptors (eg, mobile free phase[iii] hydrocarbons and associated vapour risk).

8.4.23 Despite the implementation of the robust and effective pre-construction remediation measures detailed in Section 9 of the *CoCP* Part A and B, it is recognised that some contamination may still remain and that potential impacts cannot be fully eliminated at the start of construction for example the potential for previously unidentified contamination and unexploded ordnance (UXO) would remain.

8.4.24 Some contamination is therefore considered in the base case where there is sufficient evidence to suspect the site is contaminated in the first instance.

8.5 Construction effects assessment

Assessment years

8.5.1 The assessment year considered in the construction effects assessment is Site Year 1 of construction.

8.5.2 Site Year 1 of construction has been chosen for the land quality assessment as this is likely to represent a ‘construction peak’ when land quality impacts would be most apparent. During Site Year 1 below ground construction activities, remediation and demolition works are likely to commence and lead to the disturbance of superficial soils and any potentially contaminating infrastructure.

8.5.3 The years following Site Year 1 of construction represent ‘typical years’ and it is considered that there would be no impacts from land contamination and UXO at CSO sites and tunnel drive sites dealing with excavated materials from the London Clay/Lambeth Group during this period. By Site Year 2 and onwards, site set-up, sealing of dust generation sources, and remediation (as necessary) would have taken place and the excavation of the shafts would have progressed into undisturbed soils (which in the most part are unlikely to be contaminated).

8.5.4 For tunnel drive sites that deal with excavated materials from the Chalk and Thanet Sand Formation, impacts would conservatively remain as Site Year 1 of construction throughout the construction period. This would due to the potential for the handling of contaminated soils that are produced from tunnel boring activities in these permeable strata.

8.5.5 The construction effects assessment has considered the possibility that the construction programme could be delayed by up to a year. The sensitivity of the assessment to this temporal change is taken into account in the assessment of effects. Where, as a result of a change in programme, the findings of the assessment would be likely to vary materially from those for the proposed assessment year this has been highlighted in the construction effects assessment summary.

[iii] Free phase – phase separated hydrocarbons that form a separate layer at the base or float on top of groundwater

Assessment areas

8.5.6 The geographical extent of the assessment has considered all locations where physical works and ground disturbance would take place through the surface soils.

Methodology

8.5.7 A key element of undertaking a contaminated land assessment is the development of a site conceptual model (SCM) that describes the environmental features of the site together with the expected interaction of potential contamination sources with the environment. This is done by undertaking a Source-Pathway-Receptor (S-P-R) analysis of the site, where:

a. Sources (S) are potential or known contaminant sources, eg, a former fuel storage area.

b. Pathways (P) are environmental systems through which a contaminant could migrate, eg, air, soil, unsaturated zone, and groundwater.

c. Receptors (R) are sensitive environmental receptors that could be adversely affected by a contaminant, eg, site occupiers, construction workers, building materials, or groundwater resources.

8.5.8 Where a source, relevant pathway and receptor are present, a pollutant linkage exists which could lead to an environmental impact on the receptor.

8.5.9 However, without a clear pollutant linkage being identified by the S-P-R conceptual model, the contamination may be a hazard but would not constitute necessarily a risk to human health or the environment.

8.5.10 Therefore, when assessing the potential for land contamination to cause a significant environmental effect, the extent and nature of the potential source or sources of contamination must be assessed, the pathways identified, and any sensitive receptors identified and appraised to determine their value and sensitivity to contamination related effects.

8.5.11 If a contamination source has been identified and potential sensitive receptors are present, then the likely significant effects have been determined by considering the pathways whereby the source may affect the receptors.

Significance criteria

8.5.12 The likely significant effects associated with land quality have been determined with reference to the guidelines documents identified in Section 8.3.

Determining magnitude of impacts

8.5.13 The criteria used to define the magnitude of potential land quality impacts are shown in Vol 2 Table 8.5.1 below and is based on the legislation and guidance identified in Section 8.3.

Vol 2 Table 8.5.1 Land quality – impact magnitude criteria

Impact magnitude	Definition
High	Construction workers – exposure to hazardous substances or contaminants (eg ground gas, vapours), or UXO that would present an immediate risk to health.
	Adjacent land users – exposure to hazardous substances eg ground gas or vapours that would present an immediate risk to health or exposure to harmful dusts (such as asbestos) over a prolonged duration (more than several months). High risk of UXO exposure in the absence of mitigation.
	Built environment – exposure to UXO detonation.
Medium	Construction workers – prolonged exposure to contaminants above site-specific human health criteria.
	Adjacent land users – exposure to low quantities of contaminated dusts (including asbestos) or vapours over a short to medium duration (from days to several months).
	Built environment – no medium impact possible from UXO (impacts are either high or negligible)
Low	Construction workers – short term exposure to contaminants above site-specific human health criteria.
	Adjacent and users – exposure to very low quantities of contaminated dusts or vapours over a very short period (fewer than several days).
	Built environment – no low impact possible from UXO (impacts are either high or negligible)
Negligible	No impact – contamination risks to both on and off-site receptors have been removed, remediated or assessed to be negligible. Procedures in place to manage risks, eg, specialist contractor to manage UXO risk to a level that is as low as reasonably practicable. Management systems to safely identify and remove unidentified contamination encountered during construction.

8.5.14 Although the methodology includes a 250m buffer for assessment purposes, the magnitude of impact would be greatest closest to the assessed site. Therefore, the assessment considers the impacts to the closest receptor of any given sensitivity (eg the closest housing). For receptors further from the site but within the assessed buffer, the magnitude of impacts would decrease rapidly with distance from the site.

Determining significance of effects

8.5.15 The significance of land quality effects has been determined by combining the identified impact magnitudes (Vol 2 Table 8.5.1), with the receptors affected by those impacts (taking account of their sensitivity) (Vol 2 Table 8.5.2), as set out in the generic significance matrix provided in Section 3 General EIA methodology of this volume (see Vol 2 Table 3.7.1).

8.5.16 The significance of effects listed in Vol 2 Table 8.5.2 are based upon professional judgment. Effects that are either major or moderate beneficial/adverse are deemed significant.

Vol 2 Table 8.5.2 Land quality – significance criteria

Significance of effect	Description
Major adverse	Immediate (acute) risk to human health eg exposure to asphyxiant or explosive gases or UXO Widespread severe contamination of on and off-site soils. Catastrophic damage to building/infrastructure
Moderate adverse	Medium/long term (chronic) risk to human health effects from continued exposure Contamination of on and off-site soils Significant damage to buildings/infrastructure (on or off site)
Minor adverse	Non-permanent short term health effects on humans that are easily preventable and treatable Minor, low-level and localised contamination of on-site soils Easily repairable and localised minor damage to buildings/infrastructure
Negligible	No appreciable change

8.6 Operational effects assessment

8.6.1 Design and specification would ensure that any residual historical contamination potentially remaining would be adequately managed and that the operational area is ‘fit for use’ by Year 1 of operation.

8.6.2 The design would include the construction of new hardstanding and the placement of a suitable clean imported cover in soft cover areas. This would prevent future users being directly exposed to any residual historical contamination during operation of the proposed development. These measures would be agreed with the local authority and documented within the remediation strategy for the site.

8.6.3 Additionally a number of design measures have been incorporated to ensure that the proposed development does not represent a contamination source during operation. These are as follows:

a. the design and controls are such that sewage levels would remain below the top of the main tunnel shaft when full. The system would retain the ability to overflow into the tidal Thames when at capacity.

b. the main tunnel and associated structures are designed to be well ventilated due to the nature of the tunnel contents and therefore are not at risk from residual land gas sources that may be present

c. the potential for seepage of main tunnel or shaft contents is discussed in Section 13 Water resources – groundwater of this volume.

8.6.4 Thames Water's existing environmental management procedures would be applicable to the operation of the site. Responsible environmental management would be continued by Thames Water during operation of the proposed development to prevent deterioration in land quality

8.6.5 Given the measures described above operational effects are scoped out of the land quality assessments at all Thames Tideway Tunnel project sites.

8.7 Cumulative effects assessment

8.7.1 The general approach to assessing cumulative effects is described in Section 3 General EIA methodology. The specific approach for land quality is described below. The assessment years considered for the cumulative effects assessment remain as defined in Section 8.5.

8.7.2 A comprehensive list of other developments within 1km of each site has been compiled. This list identifies developments which are:

a. under construction

b. permitted but not yet implemented and

c. submitted but not yet determined.

8.7.3 The assessment of cumulative effects has considered those other developments in categories a to c above that are programmed to be under construction or operational at the same time as the Thames Tideway Tunnel project.

8.7.4 The method for assessing cumulative effects uses a qualitative approach and the findings have not been used to re-classify the significance of any effects identified from the main assessment (Sections 8.5).

Construction effects

8.7.5 For those parts of new developments which would be under construction at the same time as construction activities on the Thames Tideway Tunnel project, these have been subject to a construction cumulative assessment.

8.8 Project-wide effects assessment

8.8.1 As described in Volume 3 Project-wide effects assessment, no project-wide land quality effects are considered likely and have therefore been scoped out of the EIA.

8.9 Assumptions and limitations

8.9.1 This section details general assumptions and limitations associated with the land quality assessment. Site-specific assumptions and limitations are detailed in Volumes 4 to 27 (land quality section).

Assumptions

8.9.2 For the purpose of this assessment it has been assumed that contamination that poses an immediate and unacceptable risk to receptors as well as any contamination that may hinder the construction programme, would have been remediated prior to the commencement of the shaft and main tunnel construction works (and in other areas of proposed excavation where necessary). This assumption has been applied to those sites where pre-construction assessment identifies the need for site-specific remediation.

Limitations

8.9.3 Baseline conditions have been established in part from historical data. Where no ground investigation has been carried out, the assessment has been entirely qualitative in nature.

8.9.4 Potentially contaminating land uses, which may have existed between the dates of the Ordnance Survey mapping, may have been omitted from the maps. As a result, Ordnance Survey mapping may not reveal all historic contamination sources.

8.9.5 Despite the limitation identified above the assessment is considered sufficiently robust.

8.10 Mitigation

8.10.1 The Thames Tideway Tunnel project has been designed to minimise environmental effects and extensive measures are included within the *CoCP* Part A and B (Section 9) such as ground investigation, contamination risk assessments and remedial measures, as well as the employment of specialist contractors, safe methods of working and robust environmental site management.

8.10.2 Where relevant measures are included within the *CoCP* they are identified in Volume 1 (for the tunnel itself) and Section 3 of Vol 4 to 27 (for each site) and have been considered as embedded measures within the assessment.

8.10.3 Where the assessment indicates significant effects having taken account of embedded measures, mitigation has been identified as appropriate.

8.11 Residual effects assessment

8.11.1 Where mitigation measures are proposed, residual effects are assessed by following the same assessment principles outlined in Section 8.5, taking into account the proposed mitigation measures.

8.11.2 Where no mitigation measures are proposed, the residual effects remain as identified through the relevant assessment.

This page is intentionally blank

References

[1] Environment Agency. *Scoping guidelines for EIA* (2002).

[2] British Standards Institute. *Investigation of Potentially Contaminated Sites: Code of Practice* BS10175 (2011).

[3] Construction Industry Research and Information Association. *Contaminated Land Risk Assessment: A Guide to Good Practice*. C552 (2001).

[4] European Union. *Water Framework Directive*, EU Directive 2000/60/CE (2000).

[5] Environment Agency. *Source Protection Zone Mapping*. Available at: http://www.environment-agency.gov.uk/homeandleisure/37833.aspx, accessed on 11 May 2012.

[6] *The Environmental Protection Act 1990*, Part 2A.

[7] Environment Agency. *Model procedures for the management of land contamination*. Contaminated Land Report 11 (2009).

[8] Department for Environment, Food and Rural Affairs. *Environmental Protection Act 1990: Part 2A Contaminated Land Statutory Guidance*, HM Government (April 2012).

[9] Department for Environment, Food and Rural Affairs/Environment Agency. *Soil Guidance Values 2009 and supporting documents,* Environment Agency. Available from http://www.environment-agency.gov.uk/research/planning/64015.aspx. Accessed 11th October 2012.

[10] Land Quality Management/Chartered Institute of Environmental Health. *Generic Assessment Criteria for the Assessment of Human Health*, 2nd Edition, Land Quality Press.

[11] CLAIRE. *Soil Generic Assessment Criteria for Human Health Risk Assessment*, Contaminated Land Application in Real Environments, London (January 2010). Available from http://www.claire.co.uk/index.php?option=com_phocadownload&view=file&id=44:Other-CLAIRE-Documents&Itemid=91. Accessed on 11th October 2012.

[12] *Infrastructure Planning (Environmental Impact Assessment) Regulations 2009*. Available at: http://www.legislation.gov.uk/uksi/2009/2263/contents/made. Accessed 17 July 2012.

[13] Department for Environment, Food and Rural Affairs/Environment Agency. See citation above.

[14] Land Quality Management/Chartered Institute of Environmental Health. See citation above.

[15] CLAIRE. See citation above.

[16] British Standards Institute. See citation above.

[17] Port of London Authority. *Thames Tideway Tunnel Foreshore Contamination Sampling Report* . PLA Ref Q55/11 (Dec 2011).

[18] 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.

[19] Department for Environment, Food and Rural Affairs/Environment Agency. See citation above

[20] Land Quality Management/Chartered Institute of Environmental Health. See citation above

[21] CLAIRE. See citation above

[22] *The Bathing Water Quality Standards, Bathing Water Directive* (76/1160/EEC).

[23] EA, SEPA and NIEA. *Technical Guidance WM2, Hazardous Waste, interpretation of the definition and classification of hazardous waste*, 2nd Edition (April 2011).

This page is intentionally blank

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.02**

Volume 2: Environmental assessment methodology

Section 9: Noise and vibration

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

Hard copy available in

Box **16** Folder **A**
January 2013

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

This page is intentionally blank

Thames Tideway Tunnel

Environmental Statement

Volume 2: Environmental assessment methodology

Section 9: Noise and vibration

List of contents

Page number

List of tables

Page number

9 Noise and vibration

9.1 Introduction

9.1.1 This section sets out the methodology for assessing the likely significant effects of the Thames Tideway Tunnel project on noise and vibration.

9.1.2 The methodology outlined in this section has been applied to all sites, unless otherwise indicated in the site assessment volumes. The methodology for assessing project-wide effects is also described.

9.1.3 The need for an assessment of noise and vibration effects results from the potential for the project to generate effects from the following sources:

a. noise from surface construction activities

b. vibration from surface construction activities

c. noise from construction road traffic on surrounding roads

d. noise from loading and unloading operations from river barges at foreshore sites

e. noise from tugs delivering and collecting barges at foreshore sites

f. groundborne noise from the operation of the Tunnel Boring Machine (TBMs)

g. groundborne vibration from the operation of the TBMs

h. groundborne noise from the operation of the temporary below ground construction railway (TCR) servicing the TBMs

i. groundborne vibration from the operation of the TCR servicing the TBMs.

9.1.4 The topic specific methodology presented in this section builds upon the general assessment methodology summarised in Section 3 of this volume and develops this to take account of the range of likely significant environmental effects on noise and vibration arising from the construction and operation of the project.

9.1.5 Noise and vibration effects are also considered in the site assessment volumes for other topics as follows: Section 5 Ecology – aquatic (vibration effects on aquatic ecology receptors), Section 6 Ecology – terrestrial (noise and vibration effects on terrestrial ecology receptors), Section 7 Historic environment (vibration effects on Listed Buildings) and Section 10 Socio-economics (noise and vibration effects on amenity of receptors).

9.1.6 Although much of the construction works would take place at some depth below ground, there are noise and vibration implications for areas surrounding the surface construction sites. Vibration from the tunnelling works could potentially cause groundborne noise and vibration impacts to surface structures closest to the tunnel alignment, particularly at shallower tunnelling depths.

9.1.7 This assessment has scoped out effects on infrastructure such as bridges, London Underground tunnels or utilities. This is because such infrastructure is not as sensitive to vibration as residential receptors which are in close proximity to each of the construction sites. The *Settlement information* paper and *CoCP Part A* Section 13 (accompanying this application) contain further information on these assets and the process for asset protection.

9.1.8 Operational noise could potentially occur at surface sites from operational plant and during tunnel filling events as water descends the combined sewer overflow (CSO) drop shafts. Although not typically an issue at other installations, the possibility of significant effects cannot be ruled-out for sensitive receptors very close to CSO drop shafts, given the volumes of water during filling events. Noise and vibration generated during tunnel filling events is considered as part of this methodology to determine the potential for effects.

9.1.9 At times other than tunnel filling events there would be some low pressure flow of air through the ventilation shafts. At Acton Storm Tanks, Carnwath Road Riverside, Greenwich Pumping Station and Abbey Mills Pumping Station, ventilation would be aided by fans (active ventilation). At all other sites there would be no fans in operation (passive ventilation). Embedded noise control measures are assumed in the design of any active ventilation systems and the noise emission is not expected to be noticeable at receptors surrounding the relevant sites relative to existing noise levels. However, the likelihood of noise emission causing any disturbance from the installations has been examined and the effects reported.

9.1.10 Routine maintenance of the mechanical, electrical, instrumentation, and control equipment at the sites would be likely to occur every three to six months and a major inspection of the tunnel and maintenance would take place every ten years. The nature and frequency of these activities has been examined for each site and any likely significant effects assessed.

9.1.11 A sensitivity test undertaken for the highway network is contained in Vol 3 Appendix J.1.

9.2 Engagement

9.2.1 The general approach adopted regarding engagement is summarised in Section 2 of this volume.

9.2.2 The key stakeholders in respect of noise and vibration are the environmental health departments of each of the local authorities.

9.2.3 An Environmental Health Officers (EHO) forum has been taking place on a regular basis through the course of the assessment. The forum meetings have been used for engagement and discussion with environmental health officers over issues such as noise survey methodology and 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*).

9.2.4 The noise survey methodology was the subject of two forum workshops in November 2010 and February 2011. The aim of the workshop was to agree a consistent approach to noise surveys for all sites and boroughs, while recognising that some may require further site-specific investigation or detail later in the process.

9.2.5 A position paper setting out the intended methodology for undertaking the noise and vibration assessment (taking into account the main points raised by stakeholders at the workshops) was circulated in December 2010 to all local authorities for comment. The comments received were discussed at the next EHO forum meeting and incorporated into the final noise survey method statements.

9.2.6 A summary of the scoping and technical engagement undertaken in relation to noise and vibration is contained in Vol 2 Appendix G.1.

9.2.7 Most of the comments are related to site-specific issues. However, as a general requirement many local authorities proposed that the sampled, attended noise measurement surveys should be supplemented with continuous monitoring over a period of several days and nights. The majority of local authorities also provided guidance on their operational noise criteria for operational plant which are set out in each site volume.

9.2.8 The IPC also provided a response to the *Scoping Report (*see Vol 2 Appendix A.3), focusing on the receptors considered including ecological receptors, consultation with local authorities and types of effects assessed. These have been addressed in this *Environmental Statement*

9.3 Legislation and guidance

9.3.1 The National Planning Policy Framework (Department for Communities and Local Government, 2012)[1] was published in March 2012. The policy framework includes high level guidance on the need for noise management in communities. Specifically, it notes that planning policies and decisions should aim to:

a. Avoid noise giving rise to significant adverse impacts on health and quality of life as a result of new development.

b. Mitigate and reduce to a minimum other adverse impacts on health and quality of life arising from noise from new development, including through the use of conditions.

c. Recognise that development would often create some noise and existing businesses wanting to develop in continuance of their business should not have unreasonable restrictions put on them because of changes in nearby land uses since they were established.

d. Identify and protect areas of tranquillity which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason.

9.3.2 Working within the Government's policy objectives, the effects of construction noise and vibration are assessed with reference to the policy and guidance detailed below.

9.3.3 BS 5228: 2009 (British Standards Institution, 2009)[2] provides guidance on the prediction and assessment of noise from construction operations and describes methods for evaluation of the significance of noise effects. The standard contains detailed information on noise reduction measures and promotes the 'best practicable means' approach to control noise and minimise the effect on local residents and construction workers.

9.3.4 The Control of Pollution Act (HMSO, 1974)[3] gives the local authority powers requiring the control of site noise under Section 60 of the Act. Under Section 61, the developer or contractor intending to carry out the works may apply in advance for consent as to the methods by which the works are to be carried out. This may include specific controls to restrict certain activities identified as causing particular problems. Conditions regarding hours of operation would generally be specified and noise and vibration limits at certain locations may be applied in some cases. All requirements must adhere to established guidance and be consistent with best practicable means to control noise only as far as is necessary to prevent undue disturbance. Further information on Section 61 consent applications is included in Part A of the *CoCP.*

9.3.5 The Environmental Protection Act (HMSO, 1990)[4] describes the duty of the local authority to take steps to abate any noise effect, including that from a construction site, deemed to be causing a statutory nuisance.

9.3.6 The *Mayor's Ambient Noise Strategy* (Mayor of London, 2004)[5] does not contain any specific policy relating to construction noise. However, it notes that in 2002, 4% of London householders considered that roadwork / demolition / construction noise was a "serious problem" (compared with 13% for traffic noise). It also states that the Mayor's aim is to secure the benefits from growth, while keeping construction noise under control. The management of construction noise is dealt with by individual boroughs.

9.3.7 Many boroughs have individual CoCPs and it is understood that a London-wide code of practice is in development although it is not yet publicly available and a completion date has not been given. The individual borough codes have been considered in developing the assessment methodology and mitigation approach. The project has produced a project wide *CoCP* for a consistent approach across the boroughs, this has assessed and considered the individual borough codes.

9.3.8 The potential for operational noise effects at any site would depend on whether it is shown that operational noise from tunnel filling events or ventilation fans has the potential to cause noise effects at nearby receptors. The methodology described in BS 4142 (British Standards Institution, 1997)[6] has been used to determine an acceptable noise level to avoid complaint according to the level (and character) of the introduced noise source relative to the background noise. If necessary, the operational noise would be mitigated relative to the local background noise levels (as defined by BS 4142) so as to prevent significant effects. These limits have been set appropriately in agreement with the local authority relative to the background noise levels at each receptor (as defined by BS 4142).

9.3.9 Vol 2 Table 9.3.1 presents the requirements within the *National Policy Statement (NPS) for Waste Water* (Defra, 2012)[7] relevant to noise and vibration and explains how the requirements have been addressed within the ES. The table also gives the location of the relevant material.

Vol 2 Table 9.3.1 Noise and vibration – requirements of the NPS and how they have been addressed

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
• Para 4.9.2 - Noise resulting from a proposed development can also have adverse impacts on wildlife and biodiversity. Noise effects of the proposed development on ecological receptors should be assessed in accordance with the Biodiversity and Geological Conservation section of this NPS.	Noise and vibration effects on ecological receptors are assessed in Section 5 Ecology – aquatic and Section 6 Ecology – terrestrial	Section 5 Ecology – aquatic and Section 6 Ecology – terrestrial, of Volumes 4 to 27 (Site specific volumes)
Para 4.9.4 of NPS notes that the applicant should include the following in the noise assessment		
• '• a description of the noise generating aspects of the development proposal leading to noise impacts, including the identification of any distinctive tonal, impulsive or low frequency characteristics of the noise'	A range of noise and vibration sources have been scoped in to the assessment as having potential to cause noise and vibration effects during construction and operation. The requirement for particular consideration of tonal or impulsive characteristics is more generally associated with operational fixed plant noise and is a requirement of BS 4142(1997). For the construction noise assessment, given the range of miscellaneous and non-continuous noise sources on construction sites it would be difficult to sufficiently quantify what types, combinations and durations of noisy activity would be classified as impulsive or tonal. It is therefore difficult to define a robust input for these factors as part of	Section 9.1 of this volume Section 9.2 of Volumes 4 to 27 (Site specific volumes)

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
	the significance criteria. It should be noted that piling is often associated with impulsive noise. The *CoCP Part A* seeks to ensure that piling methods which limit noise and vibration are selected where possible (*CoCP Part A* para. 6.4.3d) however this cannot be guaranteed and as such the assessments assume the use of vibratory piling 9.9.5. It is considered that vibratory piling does not generate impulsive, percussive noise. Construction noise is inherently variable as a result of the multiple items of plant, the movement of materials and noise from impact forces. The 'ABC' assessment criteria (BS 5228) used for the Thames Tideway Tunnel assessment were originally developed for the Channel Tunnel Rail Link (CTRL) assessment and that project was delivered against these criteria. Like the Thames Tideway Tunnel, the CTRL works generated a range of variable noise sources including some that would be more distinctive in character than others. There were few complaints about CTRL construction noise (any complaints were monitored and publicly reported on a monthly basis). This, along with the other major projects successfully assessed with the 'ABC' method, verifies the 'ABC' approach as an appropriate means for evaluating likely significant effects based on a range of construction noise sources with different frequency and temporal characteristics.	

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
• ‘• identification of noise sensitive premises and noise sensitive areas that may be affected;	An assessment area has been defined around the surface sites and tunnel alignment, and the sensitive receptors most likely to be affected have been identified.	Sections 9.5 and 9.6 of this volume
• ‘• the characteristics of the existing noise environment;’	The assessment has considered the baseline noise conditions.	Section 9.5 of this volume Section 9.4 of Volumes 4 to 27 (Site specific volumes)
• ‘• a prediction of how the noise environment will change with the proposed development: in the shorter term such as during the construction period; in the longer term during the operating life of the infrastructure; and at particular times of the day, evening and night as appropriate;’	The assessment has considered how the noise would change as a result of construction works and operation.	Sections 9.5 and 9.6 of this volume Sections 9.5 and 9.6 of Volumes 4 to 27 (Site specific volumes)
• ‘• an assessment of the effect of predicted changes in the noise environment on any noise sensitive premises and noise sensitive areas;’	The impact of noise and vibration changes has been used as the basis of an evaluation of whether significant effects would occur.	Sections 9.5 and 9.6 of this volume Sections 9.5 and 9.6 of Volumes 4 to 27 (Site specific volumes)

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
• '• measures to be employed in mitigating the effects of noise.'	Embedded environmental design measures and mitigation have been included in the prediction of noise impacts and consideration of residual effects.	Section 9.10 of this volume Section 9.8 of Volumes 4 to 27 (Site specific volumes)
• '• the nature and extent of the noise assessment should be proportionate to the likely noise impact.'	The sources of noise and vibration scoped in for assessment have been evaluated in more detail where the complexity and intensity of the effects are likely to be greater. For example, operational vibration effects can be shown to be less intense than certain more variable sources of construction vibration. The levels of assessment are therefore proportionately detailed.	Para. 9.5.14 and Para 9.6.8 of this volume
• Para 4.9.5 – 'the noise impact of ancillary activities associated with the development, such as increased road and rail traffic movements or other forms of transportation, should be considered.'	The effects of road traffic changes associated with the project have been considered.	Sections 9.5 and 9.6 of this volume Sections 9.5 and 9.6 of Volumes 4 to 27 (Site specific volumes)
• Para 4.9.6 – 'operational noise, with respect to human receptors, should be assessed using the principles of the relevant British Standards and other guidance. For the prediction, assessment and management of construction noise, reference should	The appropriate British Standard 4142 has been applied in relation to operational plant equipment noise and BS 6472 has been applied in the assessment of operational vibration. The appropriate British Standard 5228 has been applied in relation to prediction, assessment and management of construction noise	Section 9.6 of this volume Section 9.6 of Volumes 4 to 27 (Site specific volumes)

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
be made to any relevant British Standards and other guidance which also give examples of mitigation strategies.’		
• Para 4.9.7 - ‘the applicant should consult the Environment Agency and Natural England as necessary and in particular with regard to assessment of noise on protected species or other wildlife. The results of any noise surveys and predictions may inform the ecological assessment. The seasonality of potentially affected species in nearby sites may also need to be taken into account.’	The Environment Agency and Natural England have been consulted. Comments of relevance to noise and vibration and ecology are covered in the stakeholder engagement sections Volume 2.	Volume 2 Appendix G.1

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
• Para 4.9.8 – 'The project should demonstrate good design through selection of the quietest cost effective plant available; containment of noise within buildings wherever possible; optimisation of plant layout to minimise noise emissions; and, where possible, the use of landscaping, bunds or noise barriers to reduce noise transmission.'	Best practicable measures are presented with the *Code of Construction Practice*. The site assessments identify measures to mitigate noise and vibration effects where possible.	*Code of Construction Practice* Section 9.10 of this volume Section 9.8 of Volumes 4 to 27 (Site specific volumes)
• Para 4.9.1 – 'In certain situations, and only when all other forms of noise mitigation have been exhausted, the applicant may consider it appropriate to provide noise mitigation through improved sound insulation to dwellings, or, in extreme cases, through compulsory purchase of affected properties in order to gain consent for what might otherwise be	A *noise insulation and temporary rehousing policy* has been established relating to construction disturbance from noise effects. This policy could be implemented where predicted or measured construction noise levels exceed the set trigger levels. Significant adverse construction phase effects may be offset. Further information is contained in (see Schedule 2 of the *Statement of Reasons*, which accompanies this application.	Section 9.10 of this volume Section 9.8 of Volumes 4 to 27 (Site specific volumes) where applicable

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
unacceptable development.'		

9.4 Baseline data collection

9.4.1 For the purposes of the noise and vibration baseline, data describing the baseline situation is taken from a desk based review of site information and measurement surveys of noise around the surface sites to represent the noise climate.

9.4.2 Noise measurements have been taken at sensitive locations close to the surface sites that could be exposed to construction or operational noise arising from the Thames Tideway Tunnel project. These include residential areas, non-residential noise sensitive buildings and/or public amenities. The baseline results have been used to compare against the estimated noise levels associated with the construction and operation of the development. The assessment has considered how the baseline results would vary in the base case before they are assessed against the estimated noise levels associated with the construction and operation of the development.

9.4.3 Based on the *Scoping Report*, baseline noise surveys were designed to cover site construction hours for daytime working and in some cases 24 hour working. There have since been a number of sites where the potential for extended working in the evening has been identified for certain limited periods (eg, concrete pours). In addition, during stakeholder engagement many of the local authorities requested further survey measurements over longer periods or over the weekend, using continuous loggers. These changes and comments have been incorporated, where possible, in the surveys which have been undertaken. The detailed survey design for each site is described in Appendix G.1 of each site assessment volume (Vol 4 to 27). Measurements of baseline vibration have not been taken. The assessment of vibration is based on exceedance of perception or disturbance thresholds rather than change relative to baseline. Disturbance thresholds are generally well above baseline vibration exposure and are a positive assessment indicator of a potential significant effect irrespective of the baseline vibration exposure.

Desk based baseline data

9.4.4 Baseline data on existing land uses and receptors were collated from mapping resources including Ordnance Survey and aerial photography, as detailed in Vol 2 Table 9.4.1. Findings were then verified from site visits and photographs.

Vol 2 Table 9.4.1 Noise and vibration – desk based baseline data sources

Source	Data	Notes
Ordnance Survey	Location of potential noise sensitive receptors and land uses surrounding the sites	Noise sensitive receptors include (but are not restricted to) dwellings, community buildings, hospitals/healthcare buildings, hotels/hostels, offices, open/public amenity space, premises with noise/ vibration sensitive equipment, places of worship; recording studios, and schools/educational institutions
Google Earth aerial imagery	Location of potential noise sensitive receptors	N/A
Thames Tideway Tunnel project GIS	Location of potential noise sensitive receptors and land uses surrounding the site	N/A

Field survey baseline data

9.4.5 Noise surveys have been undertaken at all of the sites between March 2011 and January 2012. As noted in para. 9.4.3, baseline vibration measurements were not considered appropriate to inform this assessment.

9.4.6 At each site, measurements have been taken at locations considered to be representative of the noise climate of the nearest noise sensitive receptors to the proposed construction areas. This was usually the nearest noise sensitive building/use, unless this was very close to a dominant noise source (eg, passing traffic) and it was considered that another receptor could potentially be subject to a larger change in noise levels from the construction works.

9.4.7 On sites where construction of a foreshore structure is proposed, a measurement was also taken close to residential receptors on the bank opposite the proposed works.

9.4.8 Short sample attended measurements were undertaken where it was not possible to identify a suitable location for continuous unattended monitoring at the selected receptor location close to the proposed works, (generally due to safety and security reasons). Each measurement was 15 minutes in duration and these were completed sequentially to ensure that the multiple samples taken at any location were spread out over the full monitoring period (ie, not consecutive at any one location).

9.4.9 The measured noise parameters and time periods for the short sample measurements are detailed in Vol 2 Table 9.4.2 and Vol 2 Table 9.4.3. The parameters and sampling times were agreed with the relevant local authority in order to avoid busy peak periods and be representative of the quietest periods when noise from construction or operational ventilation noise sources could be most noticeable. All measurement periods were considered by the survey engineers to be typical of the noise climate of the sites during the inter-peak period. Specifically, there were no unusual noise sources operating to increase the baseline noise level, and traffic was considered to be flowing typically for the area.

9.4.10 At many sites it was possible to find one location suitable for an unattended continuous measurement, in agreement with the local authority. These sites were monitored over a number of weekdays and a weekend to provide additional data relating to the variation in noise climate across different periods.

9.4.11 All measurements were made using a sound level meter complying with BS EN 60804, 1991 (British Standard Institution, 1991)[8], Specification for Integrating Sound Level Meters (if manufactured prior to 2003), or to BS EN 61672, Part 1 (British Standard Institution, 2003)[9], 2003 Electroacoustics – sound level meters – specification (if manufactured after 2003).

9.4.12 All sound level meters were checked with a sound level calibrator conforming to BS 7189:1989 (British Standard Institution, 1989)[10] (if manufactured prior to 2003) or to BS EN 60942: 2003 (British Standard Institution, 2003)[11] (if manufactured after 2003) before and after each measurement, and the result of the check recorded.

9.4.13 All sound level meter kits (sound level meter and sound level calibrator) had a valid calibration certificate issued by a United Kingdom Accreditation Service (UKAS) accredited calibration laboratory (or equivalent European accreditation body). All sound level meters used for the surveys are periodically calibrated in accordance with BS 7580:1997: Parts 1 and 2 as appropriate (British Standard Institution, 1997)[12].

9.4.14 The microphone was located 1.2 to 1.5m from the ground and at least 3.5m from any reflective surfaces. Where this was not possible, measurements were taken 1m from the façade of a building such that it would be clear that the measurement was affected by façade reflection and a standard correction could be applied if necessary.

9.4.15 The measurements were undertaken when weather conditions would not affect the ambient noise levels. Any periods of precipitation were avoided and the wind speed in any direction did not exceed 5m/s. Where it was considered that conditions were not appropriate the survey was abandoned and recommenced at a later date.

Vol 2 Table 9.4.2 Noise and vibration – noise survey baseline data

Source	Data	Notes
Measured data for daytime	$L_{Aeq,T}$; $L_{A90,T}$; L_{AFmax}, Data collected over minimum of 15 minutes, at least two sets of data in each two hour period	Time periods for noise surveys are shown in Vol 2 Table 9.4.3
Measured data for night-time (where 24-hour working proposed or operational ventilation noise if required)	$L_{Aeq,T}$; $L_{A90,T}$; L_{AFmax} Data collected over minimum of 15 minutes, at least two sets of data in each two hour period	Time periods for noise surveys are shown in Vol 2 Table 9.4.3
Measured data for weekends (where 24-hour working proposed)	$L_{Aeq,T}$; $L_{A90,T}$; L_{AFmax} Data collected over minimum of 15 minutes, at least two sets of data in each two hour period	Time periods for noise surveys are shown in Vol 2 Table 9.4.3
Measured continuous logging over a number of weekdays and one weekend	$L_{Aeq,T}$; $L_{A90,T}$; L_{AFmax}, contiguous five minute samples	Unattended logged measurements taken at one receptor position as agreed with the relevant local authority

Vol 2 Table 9.4.3 Noise and vibration – attended noise field survey baseline data collection

Data collection		24 hour sites	Standard hour sites	Operational ventilation (if required)
Time periods for measurements	Weekday	10am to 12pm 2pm to 4pm 8pm to 10pm Midnight to 4am	10am to 12pm 2pm to 4pm	Midnight to 4am
	Weekend (Sunday)	2pm to 6pm Midnight to 4am	N/A	N/A

Data collection	24 hour sites	Standard hour sites	Operational ventilation (if required)
Duration of measurements	Minimum of two measurements each of 15 minutes duration logging the L_{Aeq} and L_{A90} for the whole period and at every five minutes so that shorter periods could be reported if required. Measurements for each site completed in circuits and not completed consecutively at any location.		
Parameters	$L_{Aeq,T}$; $L_{A90,T}$; L_{AFmax}		

Receptor identification and sensitivity

9.4.16 The sensitivity of a receptor to noise and vibration impacts is generally considered in terms of the type of use and the likely effects on people occupying the buildings or areas in question. There is also the potential for vibration impacts on building structures themselves at very high levels of exposure, or on particular types of highly sensitive equipment. Vol 2 Table 9.5.2 describes the potential impacts of noise and vibration in terms of human occupants. This is primarily for residential uses which would generally be considered the most sensitive use, ie, as permanent living and sleeping spaces. However, the occupants of other buildings such as community halls, libraries, offices or conference facilities would be sensitive to noise and vibration and therefore this has also been assessed.

9.4.17 The sensitivity of specialist equipment to vibration would depend on the particular type and would need to be assessed based on the manufacturer's specification for vibration tolerance. The impact of vibration on building structures is unlikely except in the case of exceptionally high levels and is assessed against the defined criteria. Vol 2 Table 9.4.4 describes typical sensitivities for a range of receptor types.

Vol 2 Table 9.4.4 Noise and vibration – typical receptor sensitivity criteria

Receptor value and/ or sensitivity*	Receptor type
High	Residential properties, hospitals, clinics/surgeries, schools, places of worship, TV / music, recording studios, recital rooms (or other sensitive performance auditoria). Particular vibration sensitivity for receptors making use of highly vibration sensitive equipment, eg microscopy, nanotechnology laboratories.
Medium	General purpose community halls, libraries, offices, conference facilities, hotels, restaurants, parks
Low	General commercial uses, retail

**The sensitivity categories shown are considered typical for the uses described, however, each case must be assessed according to its particular use and times of operation. Assigned sensitivities for particular receptors described in the individual site assessments may vary from those shown above.*

9.4.18 The level of sensitivity for any one receptor is generally classified as being the same for noise or vibration impacts. However, the assessment identifies any exceptions where, for example, the receptor may have high vibration sensitivity but medium noise sensitivity. This might occur for a building with offices (medium sensitivity) but with laboratory uses with very vibration sensitive equipment (high sensitivity).

Base case

9.4.19 The base case, for some sites, has been taken as the existing baseline situation, ie, the various noise sources and receptors which characterise the locality and are relevant to the assessment.

9.4.20 For the majority of sites, it is known that other developments in the locality would be built before the proposed Thames Tideway Tunnel project construction works, or before the operation of surface sites. These developments are set out in the site development schedules in Appendix N of each site volume. Where the base case is expected to change from current conditions, any additional receptors have been included in the assessment of effects.

Development case

9.4.21 The assessment compares the development case (ie, with the Thames Tideway Tunnel project) against the base case in any particular assessment year (see below), for construction and for operation.

9.5 Construction effects assessment

Assessment years

9.5.1 The generic approach to assessment cases is described in Section 3 General EIA methodology. The following section describes the specific approach for noise and vibration receptors.

9.5.2 Consideration is given to the extent to which the construction assessment findings would be likely to vary materially from those assessed should the programme for the Thames Tideway Tunnel project be delayed by approximately one year.

Base case

9.5.3 The noise and vibration assessment does not assess one fixed base case year for all sites. In order to have a reasonable worst-case assessment, it is assumed, that other developments in the locality that would be completed during the Thames Tideway Tunnel project construction period form part of the base case against which to assess the Thames Tideway Tunnel project construction effects. This information varies by site. As such, the base case year is identified according to the site specific information provided on the site development schedules in Appendix N of each site volume.

9.5.4 Changes in the noise and vibration climate between the baseline (as measured in the case of noise) and the base case assessment year would be very small unless there was some substantial change to the area. The assessment is considered conservative because the base case is informed by currently measured noise levels which would be slightly quieter than they would actually be just before start of construction. This is based on an assumption that there would be a small rise in ambient noise between the collection of the baseline noise data and the construction assessment year. Hence the assessed noise impacts would be slightly exaggerated.

9.5.5 To examine this further, the forecast change in traffic flows between the current year and base case years has been reviewed to verify that traffic noise is likely to alter only negligibly.

Development case

9.5.6 With regard to the development case, various assessment periods for construction have been considered in order to span the overall duration of the works. Rather than using a single assessment year, this provides more information as to how the effects of construction noise on the surrounding community would vary during the works and across the assessment period. This would be of most importance for sites with longer programmes of work.

Assessment areas

9.5.7 The assessment area is dependent upon the type of noise and/or vibration source being considered.

Construction noise

9.5.8 The assessment has considered construction noise from surface sites at unscreened receptors at a distance up to approximately 300m from the site boundary. However, in built-up areas, with relatively high ambient noise levels it would be expected that effects would be limited to a smaller radius where there are two or more intervening rows of buildings screening the works from noise sensitive receptors. The quantitative assessment therefore focuses on the receptors closest to the site or those within approximately 300m which are not substantially screened. At properties beyond these closest receptors, effects are assessed in relation to the closest receptors, and the assessment includes qualitative consideration of how the different relative positions would affect the reasonable worst-case construction noise exposure to these properties (referred to in the assessment as secondary receptors).

Construction vibration

9.5.9 Only a small number of specific types of surface construction activities give rise to significant levels of vibration from surface works and then only where they are employed close to sensitive receptors. The relevant assessment areas are therefore considered on an activity-by-activity basis.

Construction traffic noise

9.5.10 Proposed construction traffic routes from the transport assessments, and diversions or road closures as a result of the construction works have been considered within the assessment where any of the following criteria apply:

a. the flow changes are estimated to be greater than +25% or -20%

b. HGV composition could change by +/-5%

c. mean speeds could change by 10km/h.

9.5.11 These change thresholds relate to the potential for construction traffic to cause traffic noise level changes of at least 1dB. Changes below these thresholds would be considered negligible.

9.5.12 Routes from the transport assessments have been considered where they fall outside of the limits of land to be acquired or used (LLAU) boundary. Within this area, the movement of vehicles has been considered using the methodology for construction noise.

9.5.13 Movements of tugs towing river barges delivering to and removing material from the riverside sites have been considered based on measured data of equivalent barges operating on other Thames-side construction projects. The level and duration of the movements has been assessed in relation to baseline noise levels and the times of operation. The potential for noise effects are considered only around the vicinity of the construction works mooring sites and not along the barge's route along the river. This is because the barges would be closer to the receptors at the construction sites and the barge would spend longer manoeuvring into position rather than just passing by receptors further along the river.

Methodology

9.5.14 Predicted noise and vibration from surface construction activities has been calculated using the approach presented in BS 5228: 2009. This is based on the schedules of construction plant[i] proposed for the Thames Tideway Tunnel project and the typical construction programme determined for each work site[ii]. The details of typical plant and associated construction activities are shown in the appendix section of each site assessment volume. The BS 5228: Part 1 (British Standards Institution, 2009)[13] prediction method assumes typical source noise levels for the various items of plant equipment. Where possible some field measurement data of equipment being used at other construction sites has been used to augment the information provided in BS 5228: Part 1. BS 5228: Part 2 (British Standards Institution, 2009)[14] assumes typical source vibration levels for particular plant equipment. The predicted noise levels at surrounding receptors are calculated by considering the individual source

[i] The schedules are for standard construction activities on the site that could be critical in terms of noise generation and therefore for the noise assessment, but the schedules do not cover all activities that could take place.

[ii] The typical construction programme is based on an outline programme used for the environmental assessment. Durations are typical but the final contractors programme may differ.

noise levels, the numbers of pieces of plant operating for different periods of the day, the distance to the receptors and any intervening screening. For vibration, prediction parameters include the type of plant and the distance to the receptor. Average noise levels have been predicted for a typical month for any given phase of construction work; hence the variation in noise level across the entire duration of the construction programme has been determined. Vibration levels have been determined for those items of plant with potential to cause disturbance for the relevant stages of work.

9.5.15 The assessment of noise effects is made by comparing predicted noise levels during construction relative to the base case noise levels. The impact of the change in noise level is evaluated along with other parameters, such as the number of receptors and their sensitivity, in order to assess the significance of the effect. In the case of vibration, the effects are assessed in terms exceedance of particular threshold levels associated with disturbance or building damage, rather than by change relative to the base case.

Significance criteria

9.5.16 The likely significant effects on noise and vibration have been determined with reference to the guidelines published in the relevant British Standards and other guidance described below. The significance of an effect is derived from the magnitude of impact and other parameters in relation to the type of receptor and its sensitivity.

9.5.17 The number of properties impacted, duration of impact and sensitivity of receptor all contribute to determining the significance of an impact in addition to the magnitude of the impact. Therefore the impact criteria refer to ‘potential significance’ as the magnitude of impact alone does not necessarily determine whether a receptor is subject to a significant effect.

9.5.18 The significance criteria for noise and vibration were set out as part of the scoping exercise and were discussed with stakeholders during stakeholder liaison meetings.

Determining magnitude of impacts

Determining magnitude of airborne construction noise impacts

9.5.19 Noise from surface construction activities has been calculated using the approach presented in BS 5228: Part 1 (British Standards Institution, 2009).

9.5.20 An adverse impact at residential properties which could potentially cause disturbance is defined using the proven approach used to assess construction noise from the High Speed 1 project (formerly Channel Tunnel Rail Link) and Thameslink 2000 in and around London. This impact assessment method has also been adopted as part of the latest revision of BS 5228. Under this approach, the adverse impact threshold is determined at a dwelling using the existing ambient noise level, rounded to the nearest 5dB for the appropriate period (day, evening or night). This result is used to determine the assessment category: A, B or C, which then defines the adverse noise impact threshold, as described in Vol 2

Table 9.5.1. The predicted construction noise level[iii] is then compared to the appropriate noise impact threshold level to determine whether or not the threshold is exceeded.

9.5.21 If the L_{Aeq} construction noise level (ie, the noise level averaged over the working period) exceeds the appropriate noise impact threshold level, then an adverse impact with the potential to cause a significant effect is identified.

9.5.22 It should be noted that the wording of the BS 5228 'ABC method' criteria uses the term significant effect. For the purpose of this assessment, the BS 5228 derived criteria are used to identify impacts of a magnitude that could potentially cause significant effects at residential receptors. The significance of the effect is assessed using professional judgement by considering not only the BS 5228 criteria but also other factors, as discussed later in para. 9.5.39.

9.5.23 The BS 5228 A, B, C categories associated with the noise impact thresholds are defined as follows.

a. Category A: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are less than the values shown in Vol 2 Table 9.5.1.

b. Category B: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are the same as category A values shown in Vol 2 Table 9.5.1.

c. Category C: threshold values to use when ambient noise levels (when rounded to the nearest 5dB) are higher than category A values shown in Vol 2 Table 9.5.1.

9.5.24 If the ambient noise level exceeds the Category C threshold values given in Vol 2 Table 9.5.1, then a potential significant effect is deemed to occur if the construction L_{Aeq} noise level for the period is greater than the ambient noise level[iv].

Vol 2 Table 9.5.1 Noise and vibration – ABC method noise assessment criteria (construction)

Assessment period	Category and threshold values (dBL_{Aeq})		
	Category A	Category B	Category C
Daytime (0700-1900) and	65	70	75

[iii] For the purpose of this assessment, the threshold is taken to be exceeded if the **construction** noise contribution exceeds the threshold. The current BS 5228 ABC method states that an exceedance occurs when the **total** noise (ambient and construction) exceeds the threshold. This is has been reviewed by the BS 5228 technical committee who are in agreement that just construction noise and not total noise should exceed the threshold to determine potential significance. This update would be included in the next revision of the BS 5228 Standard.

[iv] The current BS 5228 ABC method states that a significant effect is deemed to occur if **total** noise increases by more than 3dB due to construction activity and the ambient noise level is greater than the Category C threshold. As **construction** noise contribution rather than total noise is used for this assessment (in agreement with BS 5228 technical committee) the equivalent situation arises when the construction noise level exceeds the Category C threshold and exceeds the ambient noise level.

Assessment period	Category and threshold values (dBL_{Aeq})		
	Category A	Category B	Category C
Saturdays (0700-1300)			
Evenings and weekends*	55	60	65
Night-time (2300-0700)	45	50	55

**1900 to 2300 weekdays, 1300 to 2300 Saturdays and 0700 to 2300 Sundays, as described in BS 5228*

9.5.25 The impact of airborne construction noise effects on non-residential sensitive receptors has been assessed according to the construction noise level relative to the ambient noise level. The likelihood of disturbance for any given receptor use has been evaluated based on the prominence of the impact.

9.5.26 At the surface construction sites, groundborne noise has not been assessed as the airborne noise from the activities at these sites would always be in excess of any groundborne noise. Groundborne noise is only considered in relation to the tunnelling activities, and the method for determining the magnitude of impact from this activity is given in Section 9.8.18 to 9.8.26. All the activities associated with the tunnelling support which are likely to generate airborne noise have been assessed at the site specific location at which they would occur.

Determining magnitude of surface construction vibration impacts

9.5.27 Where applicable, prediction of vibration from construction sources has been carried out following the procedure identified in Transport Research Laboratory Report 429 (Hiller, D.M. and Crabb, G.I. 2000)[15] on groundborne vibration caused by mechanised construction works, which is specified in BS 5228: Part 2: 2009 (British Standards Institution, 2009)[16].

9.5.28 The vibration levels affecting building occupants arising from surface construction activities can be compared to the criteria defined in Vol 2 Table 9.5.2. These VDV (vibration dose values) are based upon guidance from BS 6472: Part 1 2008 (British Standards Institution, 2008)[17].

Vol 2 Table 9.5.2 Noise and vibration – vibration criteria for building occupants

Place and time	Low probability of adverse comment – VDV $ms^{-1.75}$	Adverse comment possible – VDV $ms^{-1.75}$	Adverse comment probable – VDV $ms^{-1.75}$
Residential buildings – 16 hour day	0.2 - 0.4	0.4 - 0.8	0.8 - 1.6
Residential buildings – 8 hour night	0.1 – 0.2	0.2 - 0.4	0.4 - 0.8

Note: For offices and workshops, multiplying factors of 2 and 4 respectively should be applied to the above vibration dose value ranges for a 16 hour day. Described in BS 6472; these are construction criteria.

9.5.29 A potentially significant effect is identified where the range of vibration levels associated with 'adverse comment possible' (Vol 2 Table 9.5.2) occur, or if these levels are exceeded. The significance of the effect is assessed using professional judgement by considering not only the criteria in Vol 2 Table 9.5.2 but also other factors, as discussed later in para. 9.5.39.

9.5.30 Where it is not possible from the available information to determine the VDV levels, an alternative is to at least consider if the vibration would be perceptible. The threshold of perception in residential environments is identified as 0.3mm/s Peak Particle Velocity (PPV) in accordance with guidance in BS 5228: Part 2. Complaint is likely where levels occur above 1.0mm/s PPV at residential properties.

9.5.31 The assessment criteria for building damage are based upon guidance within BS 7385: Part 2 (British Standards Institution, 1993)[18]. The standard differentiates between transient and continuous vibration. For transient vibration the standard notes that the risk of cosmetic damage to residential buildings starts at a PPV of 15mm/s at 4Hz. The standard also notes that below 12.5mm/s PPV the risk of damage diminishes towards zero. When considering continuous vibration, the standard recommends the guide values are reduced by 50%.

9.5.32 BS 7385 (British Standards Institution,1993) highlights that the criteria for very old buildings may need to be lower if the buildings are structurally unsound. However, the standard also notes that criteria should not be set lower simply because a building is important or historic (or possibly listed for these reasons). Given that at this stage structural defect surveys have not been undertaken for buildings where there is any evidence of existing damage, and given that the risk of existing damage is greater in the historic and protected buildings along the length of the tunnels, the evaluation criteria for these receptors has been set at a lower level on a precautionary basis as described below.

9.5.33 Vol 2 Table 9.5.3 presents the quantitative evaluation criteria for the effect of transient and continuous vibration on buildings arising from tunnelling activities based on the lowest thresholds described in BS 7385 (British Standards Institution,1993).

9.5.34 Exceeding the vibration impact criteria for building damage (Vol 2 Table 9.5.3) is sufficient alone to identify a significant effect.

Vol 2 Table 9.5.3 Noise and vibration – building damage vibration criteria

Category of building	Threshold of potential cosmetic damage (Peak Particle Velocity - PPV - at building foundation)	
	Transient Vibration mm/s	Continuous Vibration mm/s
Structurally sound and non-protected buildings	12	6
Protected or potentially vulnerable buildings	6	3

Note: described in BS 7385 (British Standards Institution,1993)

Determining magnitude of construction road traffic noise impacts

9.5.35 Department of Transport Memorandum: Calculation of Road Traffic Noise (CRTN), 1988 (Department of Transport, 1988)[19] presents a procedure for the prediction of road traffic noise. The relevant parts of this procedure have been used to predict, for a given road at a reference distance, the change in noise level resulting from the change in road traffic between the base and development cases.

9.5.36 The change in road traffic noise between the base and development cases has been rated as a potentially significant effect where the change is greater than 3dB. Based on conventions used in traffic noise assessments, a semantic scale has been applied to define the scale of the impact for construction traffic which is presented in Vol 2 Table 9.5.4. The overall significance assessment is based on this and other parameters described later in para. 9.5.42.

Vol 2 Table 9.5.4 Noise – construction traffic assessment criteria

Predicted noise change	Impact scale	Rating of likely significant effect
Increase of more than 10dB	Substantial increase	Potentially significant adverse effect
Increase 6-10dB	Moderate increase	
Increase of 3-5dB	Slight increase	
Less than 3dB	Negligible change	Not significant effect
Decrease of more than 3dB	Slight decrease	Potentially significant beneficial effect

9.5.37 This methodology assesses the change in noise level over two periods, a 16 hour day/evening period (7am until 11pm) and an eight hour night-time period (11pm until 7am).

9.5.38 Where existing traffic flows fall outside the levels of applicability of the calculation method in CRTN, an approach has been taken whereby the noise level over the periods identified in para. 9.5.37 has been compared to the average ambient noise level over the period. The change criteria in Vol 2 Table 9.5.4 has then been used to determine potential significance.

Determining significance of effects

9.5.39 All of the identified sources of airborne noise and vibration have been evaluated to determine if there would be adverse impacts or the potential to cause significant effects according to the criteria described above.

9.5.40 The significance of noise and vibration effects have been determined by combining the identified impact magnitudes, with the type of receptors affected by those impacts, and the various parameters described below.

Residential receptors

9.5.41 The overall assessment of significance for residential property has been evaluated using the above criteria as well as professional judgement based on the following factors.

9.5.42 The type of effect would determine the factors to be considered, for example, exceeding the vibration impact criteria for building damage (Vol 2 Table 9.5.3) is sufficient alone to identify a significant effect.

9.5.43 For all other effects, the overall assessment of significance for a residential property has been evaluated using criteria described above as well as professional judgement based on the following factors:

a. design of the receptor (ie, whether the sound insulation provided by windows, doors and ventilation systems, is likely to be sufficient to protect the internal environment from any noise impact on the environment outside the receptor)

b. the number of receptors subject to the impacts

c. the proportion of the community subject to the impact

d. the existing absolute noise levels (particularly very noisy and quiet / tranquil areas)

e. the duration of impact.

9.5.44 With regard to the first criterion ‘a’ listed above, if the BS 5228 ABC method indicates a potentially significant noise effect, the likely noise ingress to the interior of the dwelling has also been considered. If internal noise is estimated to be above guidance levels, even with windows fully closed, the noise effect has been assessed as significant.

9.5.45 For daytime, this has been assessed against a ‘reasonable’ design guidance level of 40dBL_{Aeq} for living rooms (when they are unoccupied), taken from BS 8233 (British Standards Institution, 1999)[20]. It should be noted that this recommendation is intended as a guideline for long-term noise exposure. Therefore the duration of construction noise impact (criterion ‘e’ above) is also a consideration. For example, a short-term noise increase above the guidance level, for a month or less, would not necessarily be assessed as significant. At noise exposures below the BS

8233 daytime guidance level, the degree of impact relative to the baseline situation and the absolute resulting internal noise level have also been considered in assessing significance. This relates to significance criterion 'd' listed above.

9.5.46 In cases where the noise level difference between the outside and inside have been estimated, the type of glazing and glazed area of the affected façade has been evaluated. This has been based on a reference case for a typical residential façade, for which conservative assumptions have been made regarding glazing type and area. For example, assuming a typical 6/12/6[v] thermal double glazed window and a typical reverberant room response for an average sized living room, a noise level difference from outside to inside of 33dB has been estimated. PPG24[vi] (Department of the Environment, 1994)[21] also cites a typical noise level difference from outside to inside of 33dB for a thermal double glazed facade. BS 8233 suggests a slightly greater sound insulation from this type of glazing but this rating does not include a correction for the reverberant characteristics of the receiving room.

9.5.47 Taking the above level difference calculation as a reference case, the level difference has then been adjusted for the particular dwelling according to the type of glazing (eg single or thermal double glazed) and the glazed area of the façade. These assumptions have been based on external observations of each property in question.

9.5.48 For a situation where the windows were open slightly, a noise level difference of 15dB has been assumed (as described in WHO Guidelines for Community Noise (World Health Organisation, 1999)[22], and BS 8233 and PPG24). This allows an estimation of internal noise levels if the resident were to partially open the windows on the façade most exposed to the noise and indicates how speech communication could be affected. BS 8233 (Table 7) gives guidance on maximum steady noise levels for reliable speech communication. This recommends that steady noise levels should ideally not exceed 57dB(A) for normal voice communication at 1m or 62dB(A) for a raised voice. This relates primarily to working environments for which reliable communication is essential at all times. However, in a residential context with windows open, it is important to note that the noise levels could be reduced substantially if necessary for certain periods by closing the windows.

9.5.49 Night-time noise guidance levels are recommended in the World Health Organisation Night Noise Guidelines for Europe (World Health Organisation, 2009)[23]. This guidance refers to external noise levels and specifies an Interim Target of 55dB $L_{night,outside}$. The guidance states the following:

---

[v] Standard notation for describing double glazing dimensions, ie: 6mm pane / 12mm air gap / 6mm pane.

[vi] PPG24 has been replaced by the guidance in the National Planning Policy Framework (although the NPPF does not contain detailed guidance on noise specifically). In this case the document is cited to reference a typical noise level difference rather than policy content.

'An interim target (IT) of 55 dB $L_{night,outside}$ is recommended in the situations where the achievement of NNG[vii] is not feasible in the short run for various reasons. It should be emphasized that IT is not a health-based limit value by itself. Vulnerable groups cannot be protected at this level. Therefore, IT should be considered only as a feasibility-based intermediate target which can be temporarily considered by policy-makers for exceptional local situations.'

9.5.50 The WHO IT noise level of 55 dB $L_{night,outside}$ assumes a slightly open window. In cases where this noise level is exceeded the effect would be rated as significant. It should be noted that the WHO IT noise level assumes an average noise level difference through a slightly open window of 21dB (ie greater than the 15dB level difference assumed in other guidance cited above). The WHO Night Noise Guidance level difference of 21dB is based on averaged data taking into account the extent to which windows are opened for ventilation during the night, and the proportion of the year for which windows are partially open during the night.

9.5.51 For night-time, BS 8233 recommends a 'reasonable' design guidance level of 35dBL_{Aeq} for bedrooms (when they are unoccupied). Where construction causes noise increases above the WHO IT external noise level, a significant effect has been assessed. At noise exposures below the WHO IT external noise level, the degree of impact relative to the baseline situation and the absolute resulting internal noise level have also been considered. This relates to significance criterion 'd' listed above.

Non-residential noise sensitive receptors

9.5.52 For non-residential receptors, significant effects would be evaluated, on a receptor-by-receptor basis, using the established impact criteria (where appropriate), relevant guidance documents (British Standards Institution, 1997)[24], (Department of Education and Skills)[25], (Department of Health)[26] and professional judgement based on the factors below.

9.5.53 As is the case for residential receptors, exceeding the vibration impact criteria for building damage is sufficient alone to identify a significant effect whereas for all other effects additional consideration is given to:

a. receptor's use (eg, educational, healthcare, religious or community)

b. times of use

c. existing internal noise levels compared to relevant guidance on noise for the particular use

d. design of the receptor (eg, whether the sound insulation provided by windows, doors and ventilation systems, is likely to be sufficient to protect the internal environment from any noise impact on the environment outside the receptor)

e. the duration of impact.

[vii] NNG is the Night Noise Guideline for which the guidance recommends 40dB $L_{night,outside}$ as an aspiration. However, the guidance notes that a night-time noise level of this degree of quietness is not achievable in many situations, hence the Interim Target of 55dB $L_{night,outside}$.

9.5.54 In the case of public open spaces (such as parks), BS 5228 notes that an increase of 5dB(A) or more above ambient noise level continuously for a month or more might be deemed to be a significant effect. The extent of the area of impact would also need to be considered.

9.6 Operational effects assessment

Assessment years

Base case

9.6.1 The operational base case for assessment is the equivalent of Year 1 of operation but without the project.

9.6.2 As described for construction effects, the baseline noise measurement surveys are generally considered to represent the base case noise climate. However, the change in traffic flows between the current and base case years has been examined to verify that traffic noise is unlikely to alter. Changes over the intervening period would be expected to be negligible provided no major changes in the local road network are subsequently proposed.

9.6.3 Consideration is given to the extent to which the construction assessment findings would be likely to vary materially from those assessed should the programme for the Thames Tideway Tunnel project be delayed by approximately one year.

Development case

9.6.4 It has been assumed that the plant would be operational from Year 1 of operation and this would constitute the operational development case.

Assessment areas

9.6.5 The assessment area is dependent upon the type of noise or vibration source being considered. Traffic noise associated with the operation of the tunnel and surface sites would be limited to infrequent maintenance visits to the sites generally by single vehicles. The effects are considered negligible relative to base case traffic and are not assessed further.

Plant machinery noise

9.6.6 The operational effects of plant machinery noise associated with active ventilation of the tunnel and other plant that would be operational at above ground structures have been considered for sensitive receptors around the sites. Noise would be controlled to within appropriate target noise levels agreed with the local authorities at the closest sensitive receptors. The position of the closest receptors therefore defines the assessment area for each site.

Tunnel filling noise

9.6.7 Operational noise effects also include consideration of tunnel filling events and any associated noise break-out at closest receptors. However, it is known from existing data obtained for this source that noise emissions would be low relative to ambient noise and it would only be necessary to consider the closest sensitive receptors.

Methodology

9.6.8 As for construction effects, the assessment of operational noise effects is made by considering the change in noise relative to the base case. The impact of the change in noise level is evaluated along with other parameters, such as the number of receptors and their sensitivity, in order to assess the significance of the effect.

Noise from plant machinery at above ground structures

9.6.9 The noise levels reaching receptors from the ventilation system would be controlled by appropriate mitigation if appropriate to limit the noise emission to acceptable levels. Based on the emission levels from any active ventilation plant, the overall noise level has been predicted to determine if mitigation would be required. The appropriate emission limits, based on local authority requirements to ensure that no adverse effects would occur, are set out in each site assessment volume. Noise emission limits are set relative to the average background noise level for the appropriate period, ie, daytime or night-time monitoring periods as specified in Vol 2 Table 9.4.3.

Tunnel filling events - noise and vibration prediction

9.6.10 The results of studies (Jain, S.C. and Kennedy, J.F. 1983)[27] to investigate noise and vibration during tunnel filling events, which were carried out in 2011 at existing sites in the United States (US), have been used to inform this assessment. These example sites were selected because they have a vortex design to control the fall of water around the inside wall of the drop shaft. This is a similar design to that proposed for the Thames Tideway Tunnel project and is therefore representative of potential noise emission during filling events for the sites.

9.6.11 The US studies demonstrated that tunnel filling events gave rise to low levels of noise and vibration. Measurements were taken for these studies, during storm and non-storm events, at drop structures equivalent to those proposed for the Thames Tideway Tunnel project. The highest noise level measured directly over the drop shaft was 61dBL_{Aeq} during a worst-case storm event. The noise levels at receptors around the drop shaft would be considerably attenuated by distance at the receptor positions. The likelihood of disturbance from tunnel filling events has been assessed relative to the ambient noise levels at each site reported in the site assessment volumes.

9.6.12 As part of the same studies, the highest peak particle velocity (PPV) measured directly at the example drop shaft sites was 0.034mm/s. The measured PPV values are well below the levels for vibration to be just perceptible, according to the criterion referenced later in this section. Similarly, the levels would be well below the transient and continuous vibration guideline criterion for building damage. The likelihood of vibration effects from tunnel filling events has been assessed at each site reported in the site assessment volumes.

Significance criteria

Determining magnitude of impacts

9.6.13 The methodology used to assess potential noise effects from active ventilation at surface site installations is based on the approach described in BS 4142. This considers the likelihood of complaint according to the noise level (and character) of the predicted operational noise relative to the background noise level. The plant machinery has been designed to meet the local authority requirements to avoid disturbance at the closest residential receptors.

9.6.14 The impact of operational noise effects on non-residential sensitive receptors has been assessed according to the operational noise level relative to the ambient noise level. The likelihood of disturbance for any given receptor use has been evaluated based on the prominence of the impact. The impact of tunnel filling events on all receptors has also been assessed relative to ambient noise.

9.6.15 The potential for vibration from water descending the CSO drop shafts has been assessed using BS 6472 (British Standards Institution, 2008) to determine the likelihood of adverse comment by the occupants of nearby buildings. As for other potential vibration sources, any impacts would be assessed based on the guidance in BS 6472 (British Standards Institution, 2008) (Vol 2 Table 9.5.1).

Determining significance of effects

9.6.16 The overall significance of operational effects is determined using the same significance criteria described for the assessment of construction noise and vibration.

Residential receptors

9.6.17 The significance of effects for residential property has been evaluated by considering the impact magnitude as well as professional judgement based on the following factors.

9.6.18 The type of effect would determine the factors to be considered, for example, exceeding the vibration impact criteria for building damage (Vol 2 Table 9.5.3) is sufficient alone to identify a significant effect, whereas for all other effects additional consideration is given to:

a. the number of receptors subject to the impacts

b. the proportion of the community subject to the impact

c. the existing absolute noise levels (particularly very noisy and quiet / tranquil areas).

Non-residential noise sensitive receptors

9.6.19 For non-residential receptors, significant effects would be evaluated, on a receptor-by-receptor basis, using the established impact criteria (where appropriate) and professional judgement based on the factors below.

9.6.20 As is the case for residential receptors, exceeding the vibration impact criteria for building damage is sufficient alone to identify a significant effect whereas for all other effects additional consideration is given to:

a. receptor's use (eg, educational, healthcare, religious or community)

b. times of use

c. existing internal noise levels compared to relevant guidance on noise for the particular use

d. design of the receptor (eg, whether the building envelope, ie, sound insulation provided by windows, doors and ventilation systems, is likely to be sufficient to protect the internal environment from any noise impact on the environment outside the receptor).

9.7 Cumulative effects assessment

9.7.1 The general approach to assessing cumulative effects is described in Section 3. The specific approach for noise and vibration is described below. The assessment years considered for the cumulative effects assessment remain as defined in Sections 9.5 and 9.6 above.

Construction

9.7.2 Cumulative construction noise and vibration effects could potentially arise as a result of other planned developments in the area of each site. Based on the available planning information for the locality of each surface site, the potential cumulative effects have been considered qualitatively. The likelihood of other developments resulting in increased effects relative to those caused by the Thames Tideway Tunnel project sites themselves would depend on the proximity of the other developments and their likely noise emission relative to the ambient noise climate. This is assessed on a site-by-site basis and described in the site assessments. These factors have been considered in order to qualitatively evaluate any construction noise cumulative effects. The surrounding developments which could potentially cause cumulative effects have been identified from schedules of planned developments in the vicinity of each site (see site development schedules, Appendix N of Volumes 4 to 27).

Operation

9.7.3 It is expected that any operational effects associated with noise emission from ventilation plant or tunnel filling events would only affect the closest properties immediately around the sites. However, the likelihood of other developments resulting in increased operational noise effects relative to those caused by the sites would depend on the proximity of the other developments. This is assessed on a site-by-site basis and described in the site assessments. These factors have been considered in order to qualitatively evaluate any cumulative operational noise effects. The surrounding developments which could potentially cause cumulative effects have been identified from schedules of planned developments in the vicinity of each site (see site development schedules, Appendix N of Volumes 4 to 27).

9.8 Project-wide effects assessment

9.8.1 The general approach to assessing the likely significant effects, including project-wide effects, is described in Section 3. The specific approach for assessing construction noise and vibration is described below. Operational project-wide effects for noise and vibration have not been assessed (see Volume 3).

9.8.2 Noise and vibration effects are relatively localised around a fixed source. Given the separation of the surface sites it is not generally anticipated that there would be project-wide effects resulting from the summation of noise or vibration effects from individual sites, for construction or operation. However, in the case of Kirtling Street and Heathwall Pumping Station which are close to each other, there is potential for noise from both sites to result in combined effects and these are considered in the relevant site assessments.

9.8.3 Noise effects from construction traffic accessing different surface sites in a particular area could potentially interact to produce greater effects than would have resulted from a single site and the total traffic is considered where this might occur.

9.8.4 The noise and vibration effects of activities associated with the underground works required for the construction of the project are considered in Volume 3.

Assessment years

9.8.5 The assessment years for project-wide effects are the same as those described in Section 9.5 for construction.

Assessment areas

9.8.6 The assessment areas for project-wide effects are the same as those described in Section 9.5 for construction.

Groundborne noise and vibration from tunnelling

9.8.7 Groundborne noise and vibration from the tunnel construction works would potentially affect receptors in a corridor directly above the tunnel, depending upon the tunnel depth at that particular location. The assessment has considered the main tunnel, the Frogmore and Greenwich long connection tunnels, and the short connection tunnels at Hammersmith Pumping Station and Falconbrook Pumping Station[viii], including the operation of the tunnel boring machines, (TBMs), and in-tunnel temporary tunnel construction railways (TCRs).

9.8.8 The highest level of groundborne noise and vibration associated with the tunnelling works would be caused by the operation of the TBM. Using the methodology stipulated in BS 5228: Part 2 (British Standards Institution, 2009) the ‘low’ impact classification for groundborne noise at residential

---

[viii] Construction of the short connection tunnels have only been assessed at these sites as they run beneath properties before going under the river to the main tunnel. The short connection tunnels at other sites run wholly beneath the river and there are no sensitive receptors within the assessment area.

receptors occurs at a distance of approximately 65m. This takes into consideration the worst-case potential amplification as a result of the building's construction and assumes the prediction of the upper-bound[ix] groundborne noise from the operation of tunnelling equipment.

9.8.9 At this distance, again using the prediction methodology stipulated in BS5228: Part 2: 2009 (British Standards Institution, 2009), the predicted resultant vibration level is less than 1mm/s. Furthermore, the prediction methodology states that, in soft ground (such as those conditions through which the sections of the main tunnel is routed), this is likely to be excessively conservative and the constant term, and hence level of impact could reasonably be reduced by an order of magnitude.

9.8.10 Therefore the assessment area for the groundborne noise and vibration assessment for residential receptors is limited to within the 'Low' impact classification, which is typically within a 65m radial distance of the tunnel crown.

9.8.11 Consideration has also been given to sensitive non-residential receptors, such as recording studios, theatres or other environments where transient or low background noise levels are important to the operation of the building and which are more sensitive to groundborne noise than residences. As these are potentially more sensitive to lower levels of groundborne noise, the assessment area for non-residential receptors is 100m.

9.8.12 In addition land uses where low ambient vibration is critical to operations include vibration sensitive research and manufacturing; hospitals with vibration sensitive equipment and procedures; and some university research operations, such as microscopy. The degree of sensitivity to vibration would be dependent on the specific equipment and operations in the building. Equipment such as electron microscopes and high resolution lithographic equipment can be sensitive to vibration. Manufacturing of computer chips is an example of a vibration sensitive process.

9.8.13 Buildings with such sensitive equipment and processes are generally located outside urban areas away from sources of environmental vibration such as surface and underground trains. Where they are located in urban areas (eg, hospitals) then mitigation measures would generally be in place to protect the sensitive equipment and operations from external sources of environmental vibration. In all cases, such equipment and processes would already be protected from internal occupational vibration (eg, footfalls and door slams) which means that sensitivity of such facilities to new external sources of environmental vibration is less than might be anticipated based on the sensitivity of the equipment itself.

9.8.14 Nonetheless, using a precautionary approach, mapping and datasets have been used to identify potentially vibration sensitive land uses that are within 250m of the main and connection tunnels. Following review of these data, any land uses where low ambient vibration could be critical to

[ix] The upper-bound groundborne noise refers to a statistically highest (worst-case) range of noise levels from the empirical dataset given in BS5228: Part 2: 2009. It was this data that was used for the tunnelling noise prediction.

operations have been investigated further by contacting the owner to confirm the exact type of use and any in built mitigation/attenuation. Any such receptors are identified in the project-wide assessment.

Methodology

9.8.15 The assessment methodology for project-wide groundborne noise effects from construction is presented below. The project-wide assessment does not consider airborne noise from the tunnelling and support activities, as these are included in the individual site assessments to which they are applicable.

9.8.16 The assessment methodology for vibration is the same as that described in Section 9.5 for construction.

9.8.17 Prediction of groundborne noise and vibration from a TBM has been undertaken using the procedure identified in Transport Research Laboratory Report 429 on Groundborne vibration caused by mechanised construction works, which is specified in BS 5228: Part 2: 2009 (British Standards Institution, 2009).

Significance criteria

Determining magnitude of impacts

9.8.18 Determining the magnitude of impacts for project-wide surface effects has been carried out as described in Section 9.5 and 9.6 for construction and operation respectively.

Determining magnitude of groundborne noise and vibration impacts from a TBM

9.8.19 There are no relevant national or international standards setting criteria for groundborne noise. The impact criteria set out in Vol 2 Table 9.8.1 and Vol 2 Table 9.8.2 have therefore been drawn from similar projects in the UK, ie, Crossrail, the Jubilee Line and High Speed 1. These criteria were agreed with the local authorities, stakeholders and at parliamentary review.

9.8.20 These projects assessed groundborne noise in terms of the absolute level of noise generated by a train passing by. Absolute criteria, rather than noise change criteria, apply for groundborne noise for three main reasons. Firstly there is rarely any appreciable ambient groundborne noise at a receptor. Secondly, the character and nature of groundborne noise differs from other ambient noise heard inside buildings. Thirdly, the body of experience and research available with regard to human response to groundborne noise has mostly been based on this noise indicator. The overall significance assessment in the table below is based on this and other parameters described in para. 9.5.42.

Vol 2 Table 9.8.1 Noise – (groundborne) assessment criteria - residential

Impact classification	Groundborne noise Level $dBL_{Amax, slow}$ (measured indoors, near the centre of any dwelling room on the ground floor)	
Negligible	< 35	Not significant
Low	35-39	
Medium	40-44	Potentially significant effect
High	45-49	
Very High	>49	

Vol 2 Table 9.8.2 Noise – (groundborne) impact criteria - non-residential

Building	Likely significant effect threshold $dBL_{Amax, slow}$
Theatres / large auditoria and concert halls	25
Sound recording / broadcast studios	30
Places of meeting for religious worship / courts / Lecture theatres / museums / small auditoria or halls	35
Offices / schools / colleges / hospitals / hotels / libraries	40
Factories / warehouses	50

9.8.21 The magnitude of impact of groundborne vibration has been assessed in respect of human comfort and building damage in the same manner as that of vibration at surface sites. This is as described in paras. 9.5.26 to 9.5.34.

9.8.22 Where buildings are utilised for more than one use, then the building has been assessed on the basis of the most sensitive use.

Determining magnitude of groundborne noise and vibration impacts from underground temporary construction railway (TCR)

9.8.23 The TCR can generate groundborne noise and vibration in the same way as a permanent railway. The impact of the proposed supply train operations has been calculated using the empirical calculation method developed and validated initially for the design and construction of High Speed 1 which includes 15km of twin bore tunnel under London. This approach is also compliant with ISO 14837-1: 2005 (International Standard Organisation, 2005)[28], which provides guidance on the calculation and assessment of railway groundborne noise and vibration.

9.8.24 The method is empirical, developed from thousands of measurements, and takes account of key parameters, including tunnel design, tunnel depth, ground conditions, receiving building foundations and receiving building type.

9.8.25 Typically groundborne noise and vibration levels from TCRs are less than those associated with the operation of the TBMs. It should be noted though that the TBM would be a more transitory impact as it moves past any given receptor, whereas the TCR would be a more sustained source at a given receptor as the tunnelling work continues.

9.8.26 The impact criteria specified above have been used when considering groundborne noise and vibration from supply trains.

Determining significance of effects

9.8.27 The methodology for identifying the magnitude of impact for airborne noise and groundborne noise are different. However, having determined the magnitude of impact, the method of determining the significance of effects from the impact magnitude for project-wide noise and vibration effects is the same as that described in Section 9.5 and 9.6 for construction and operation respectively.

Project-wide cumulative effects

Construction

9.8.28 Cumulative effects are assessed at surface sites for construction but it is considered unlikely that there would be project-wide cumulative effects for tunnelling activities. However, of the schemes outlined in the development schedule (Vol 3 Appendix A.1), Crossrail and the Northern Line Extension are considered as part of the project-wide construction cumulative assessment as they are assumed to be under construction at the same time as the Thames Tideway Tunnel and would involve tunnelling activities.

9.8.29 For engineering and settlement reasons, tunnels are not bored over the same area at the same time. Therefore, for the same reasons it is unlikely that the tunnels associated with this Project and Crossrail and the Northern Line Extension will be constructed at the same time through the same area. This is discussed further in the project-wide assessment.

Operation

9.8.30 Cumulative effects are considered at surface sites for operation but it is unlikely that there would be project-wide operational cumulative effects. This is because operational sources would be expected to be highly localised and not cause cumulative effects beyond the assessment areas of the individual surface sites.

9.9 Assumptions and limitations

9.9.1 This section details general assumptions and limitations associated with the noise and vibration assessment. Site-specific assumptions and limitations are detailed in Volumes 4 to 27 (noise and vibration section).

Assumptions

9.9.2 The assessment has been carried out according to the full methodologies of the appropriate guidance using the relevant assessment criteria.

9.9.3 The assessment is based on an assumption that there would be a small rise in ambient noise between the collection of the baseline noise data and the construction assessment year (see para. 9.5.4). If the noise levels were to vary, it is likely that the noise levels would increase compared to the measured data from 2011 (due to natural traffic growth and noise from adjacent developments where applicable). The developments set out in the site development schedule (Appendix N of each site volume) provide an indication of the adjacent developments that could contribute towards the rise in ambient noise level. It would however, be difficult to accurately predict the future baseline ambient noise levels and the assessment is therefore based on data from 2011 which presents a reasonable worst-case.

9.9.4 The construction plans and associated plant schedules (located in the appendices of each site volume) used for the assessment are considered adequately detailed to determine noise and vibration effects from construction noise. The activities are considered to be representative of the range of noise and vibration generating activities. These are for standard construction activities on the site that could be critical in terms of noise generation.

9.9.5 The assessment has assumed the installation and removal of piles using vibratory methods across all sites as it cannot be guaranteed at this stage that ground conditions would allow other methods of piling. However, the *CoCP* (section 6.4) includes a measure to select piling methods which limit noise and vibration to acceptable levels such as silent piling where possible The assessment has also assumed that where plant is contained within a structure, the structure provides a basic level of noise attenuation.

9.9.6 The predicted construction noise levels represent a reasonable worst-case forecast of noise levels at a given receptor within any month of the construction works, as defined by the construction parameters.

9.9.7 As identified in para. 9.4.8, where it was not possible to identify a suitable location for continuous unattended monitoring at the selected receptor location close to the proposed works, generally due to safety and security reasons, short sample attended measurements were undertaken instead. Each measurement was 15 minutes in duration and these were completed sequentially to ensure that the multiple samples taken at any location were spread out over the full monitoring period (ie, not consecutive at any one location).

Limitations

9.9.8 Within the context of the described methodology there are no limitations to the assessment approach.

9.10 Mitigation and compensation

Construction

9.10.1 The Thames Tideway Tunnel project has been designed to minimise environmental effects and therefore the construction design/methods take account of noise and vibration considerations including general and best practicable measures described in BS 5228. These would be applied routinely at all sites through *Part A* of the *CoCP*. The *CoCP* establishes the framework within which noise and vibration as a result of the works would be controlled. The development of the noise and vibration control measures has been an iterative process. For each site, the particular activities causing the highest impacts have been identified (by prediction) and alternatives sought, or control measures designed-in to the methodology where practicable to remove or minimise significant effects.

9.10.2 Site-specific environmental design measures have also been assumed at individual sites where particular noise sources have been identified as potentially contributing significantly to the construction noise effects at a receptor. For example, such measures include localised enclosures for particular items of plant, or increased boundary screening at a particular position. These measures form part of the project and have been considered as embedded environmental design measures within the assessment and are identified where necessary as site-specific measures in *Part B* of the *CoCP*.

9.10.3 The *CoCP* requires that contractors apply for Section 61 consents (s.61) under the Control of Pollution Act 1974. Such consents set out the method of working, the working hours, measures to be employed to minimise construction noise and vibration and location of works. For consent to be granted the local authority must consider that the methods and the mitigation proposed are considered to demonstrate that best practicable means has been adopted to minimise construction noise and vibration at all times. The *CoCP* requires that the construction works be undertaken in accordance with the consent.

9.10.4 Where the assessment indicates significant effects, having taken account of embedded environmental design measures, mitigation has been considered where practicable.

9.10.5 Vibration mitigation can include measures such as compaction using alternative machinery generating the lowest practicable vibration levels which still enables the required level of compaction to be completed. The requirement to use this plant would relate to receptors very close to the works and it would not be necessary to apply this routinely at sites where significant effects have not been assessed. Using smaller plant operating at a lesser vibration intensity could have ramifications for the duration and cost of the particular process and hence would not be selected without particular reason.

9.10.6 The project has established a *noise insulation and temporary rehousing policy* relating to construction disturbance from noise effects. The policy seeks to offset the effects arising from disturbance and would be implemented where predicted or measured construction noise levels exceed trigger levels, although there is no guarantee that the noise control measures would be accepted by the affected party. Significant adverse construction phase effects may be offset by the implementation of these measures. Further information is contained in Schedule 2 of the *Statement of Reasons* which accompanies this application.

9.10.7 Those residents or non-residential building occupants who are not eligible for measures under the *noise insulation and temporary rehousing policy* may be eligible to apply for compensation through the *Thames Tideway Tunnel project compensation programme* (see Schedule 2 of the *Statement of Reasons*, which accompanies the application for development consent). This has been established to address claims of exceptional hardship or disturbance during and as a result of construction activities. The programme measures are not considered to be mitigation as there is no guarantee that the property in question would be eligible for compensation or that the compensation would be accepted by the affected party. The residual effects reported in the ES therefore do not take the compensation programme into account.

Operation

9.10.8 The Thames Tideway Tunnel project has been designed to minimise environmental effects and therefore the design takes account of noise and vibration considerations for fixed plant design criteria. Where such measures form part of the project, they are identified in Volume 1 (for the tunnel) and Section 3 of Volumes 4 to 27 (for each site) and have been considered as embedded environmental design within the assessment.

9.11 Residual effects assessment

9.11.1 Where mitigation measures are proposed, residual effects are assessed by applying the same methods and criteria as for the main assessment. The residual effects assessment assumes the same assessment areas and years as the main assessment.

9.11.2 Where no mitigation measures are proposed, the residual effects remain as identified through the relevant assessment (construction, operation or project-wide).

References

[1] Department for Communities and Local Government, *National Planning Policy Framework,* (2012). Available at: http://www.communities.gov.uk/publications/planningandbuilding/nppf.

[2] British Standards Institution. *BS 5228 Code of practice for noise and vibration control on construction and open sites*, (2009).

[3] HMSO. *Control of Pollution Act*, (1974).

[4] HMSO. *Environmental Protection Act*. (1990).

[5] Mayor of London. *Sounder City*, *The Mayor's Ambient Noise Strategy* (2004).

[6] British Standards Institution. *BS 4142 Method for rating industrial noise affecting mixed residential and industrial areas*. (1997).

[7] Department of Environment, Food and Rural Affairs (DEFRA). *National Policy Statement for Waste Water: A framework document for planning decisions on nationally significant waste water infrastructure* (2012).

[8] British Standard Institution. *BS EN 60804, Specification for the verification of sound level meters*. (1991).

[9] British Standard Institution. *BS EN 61672, Part 1, Electroacoustical performance specifications of sound level meters*. (2003).

[10] British Standard Institution. *BS 7189:1989, Specification for sound calibrators*. (1989).

[11] British Standard Institution. *BS EN 60942, Electroacoustics. Sound calibrators*. (2003).

[12] British Standard Institution. *BS 7580: Parts 1 and 2, Specification for the verification of sound level meters*. (1997).

[13] British Standards Institution. BS 5228: *Part 1 Code of practice for noise and vibration control on construction and open sites.* (2009).

[14] British Standards Institution. BS 5228: *Part 2 Code of practice for noise and vibration control on construction and open sites.* (2009)

[15] Hiller, D.M. and Crabb, G.I. *Groundborne vibration caused by mechanised construction works*. TRL Report 429, Berkshire: Transport Research Laboratory. (2000).

[16] British Standards Institution (2009). See citation above.

[17] British Standards Institution. *BS 6472: Part 1 Guide to evaluation of human exposure to vibration in buildings Part 1: Vibration sources other than blasting*. (2008).

[18] British Standards Institution. *BS 7385: Part 2 Evaluation and measurement for vibration in buildings – Guide to damage levels from groundborne vibration*. (1993).

[19] Department of Transport Welsh Office. *Calculation of Road Traffic Noise,* HMSO. (1988).

[20] British Standards Institution. *BS 8233*. *Sound insulation and noise reduction for buildings. code of practice*. (1997).

[21] Department of the Environment (now replaced by National Planning Policy Framework). *Planning Policy Guidance 24,Planning & Noise.* (1994)

[22] World Health Organisation. *Guidelines for Community Noise.* (1999).

[23] World Health Organisation. *Night Noise Guidelines for Europe*. (2009).

[24] British Standards Institution. *BS 8233*. *Sound insulation and noise reduction for buildings. code of practice*. (1997).

[25] Department of Education and Skills. Building Bulletin 93: *Acoustic design in schools*.

[26]Department of Health. Acoustics*: Technical design manual*, Version 0.6: England.

[27] Jain, S.C. and Kennedy, J.F. *Vortex-Flow Drop Structures for the Milwaukee Metropolitan Sewerage District Inline Storage System*. Iowa Institute of Hydraulic Research. IIHR Report No 264 (Jul 1983).

[28] International Standard Organisation. *Mechanical vibration -- Ground-borne noise and vibration arising from rail systems -- Part 1: General guidance*. (2005).

This page is intentionally blank

Thames Tideway Tunnel
Thames Water Utilities Limited

Thames Water

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.02**

Volume 2: Environmental assessment methodology

Section 10: Socio-economics

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

Hard copy available in

Box **16** Folder **A**
January 2013

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

This page is intentionally blank

Thames Tideway Tunnel

Environmental Statement

Volume 2: Environmental assessment methodology

Section 10: Socio-economics

List of contents

Page number

List of plates

Page number

List of tables

Page number

10 Socio-economics

10.1 Introduction

10.1.1 This section sets out the methodology for assessing the likely significant effects of the Thames Tideway Tunnel project on socio-economics.

10.1.2 The methodology outlined in this section has been applied to all sites, unless otherwise indicated. The methodology for assessing project-wide effects is also described in Section 10.8.

10.1.3 The need for an assessment of socio-economic effects results from the potential for the project to generate impacts at a site specific and / or project-wide level upon the economy, social infrastructure, facilities and services, and the local amenity experienced by various receptors.

10.1.4 The topic specific methodology presented in this section builds upon the general assessment methodology summarised in Section 3 of this volume and develops this to take account of the range of likely significant environmental effects on socio-economics arising from the construction and operation of the project.

10.1.5 The amenity assessment involves the consideration of potential air quality, construction dust, noise, vibration (human response) and visual impacts. The environmental impact assessment (EIA) methodologies for these topics are set out in the respective technical sections of this volume. An understanding of these topic assessment methodologies and related effects is required for the assessment of potential amenity effects on socio-economic receptors.

10.2 Engagement

10.2.1 The general approach adopted regarding engagement is summarised in Section 2 EIA process, consultation and engagement.

10.2.2 For socio-economic effects, key stakeholders include local authorities, community groups, businesses and the general public. Engagement with these stakeholders has been an ongoing process.

10.2.3 The *Scoping Report* (Thames Water, 2011) was published in March 2011 providing stakeholders with an opportunity to provide opinions on all topics including socio-economics. This allowed stakeholders to identify any sensitive receptors that they felt required assessment. The scoping opinions are included in Vol 2 Appendix A. For example, as shown in Vol 2 Appendix A.3, the IPC provided comments on the *Scoping Report* on amenity, employment and business impacts which have all been assessed as part of this *Environmental Statement*.

10.2.4 In summer 2011, a methodology was prepared for collecting baseline field survey data on the use of open spaces (see Vol 4-27 Appendix H.1 for further detail). The relevant local authorities were consulted regarding this methodology and, where a response was received, it has been taken into account and the methodology adapted accordingly. Any changes to the survey methodology as a result of these responses are explained in the relevant site volumes.

10.2.5 Phase two public consultation was undertaken between November 2011 and February 2012. This included the publication of a *Preliminary environmental information report* (*PEIR*) which set out the detailed assessment methodology, baseline conditions and preliminary assessment results (based on the phase two scheme) for socio-economics.

10.2.6 Site specific responses from statutory stakeholders to the phase one, phase two, interim, targeted and section 48 consultations have been compiled and responded to within the respective site volumes (Volumes 4 to 27).

10.2.7 Local authorities have also been consulted on the economic impact of the project; in particular in regard to the opportunity for Thames Water to effect positive outcomes for local workers in terms of skill development and employment opportunities. In early autumn 2012, direct one to one telephone discussions were held with the economic development officers of the local authorities within which sites assessed in the ES are located who agreed to participate. This was followed by an employment and skills strategy forum (consulting the same forum which had been convened by Thames Tideway Tunnel in 2011 and May 2012) held in early December 2012. The forum invited feedback on the draft employment and skills strategy, and informed its subsequent refinement. As well as including local authorities, the December 2012 forum was also comprised of wider stakeholders including the Greater London Authority, business groups and job brokerage agencies.

10.2.8 A summary of the scoping and technical engagement undertaken in relation to socio-economics is contained in Vol 2 Appendix H.1. Issues raised in relation to the socio-economics include the identification of receptors and effects for assessment, the assessment methodology and the requirement for a skills and employment strategy.

10.2.9 Thames Water has also undertaken extensive engagement with businesses, public sector bodies and community organisations that have commercial, operational and / or community facility premises near to the proposed construction sites and who may be affected by the proposed works. Information volunteered by the stakeholders during this process has been used to inform the socio-economic baseline and assessments.

10.3 Legislation and guidance

10.3.1 There is no dedicated UK legislation that specifies the detailed content required for socio-economic assessments or that provides appropriate standards and thresholds for determining impact significance. However, there is relevant planning policy and best practice guidance, including relevant standards found therein, which are of relevance to socio-economic impact assessment. Accordingly, the socio-economic assessment has been undertaken with reference to such policy, guidance and standards where appropriate, as well as using professional judgement.

10.3.2 The key planning policy of relevance is the *National Policy Statement (NPS) for Waste Water* (Defra, 2012)[1]. It lists a series of generic impacts, including impacts related to socio-economics, which it considers will be relevant to the assessment of waste water infrastructure. This assessment has had regard that list although it is noted that the list is not intended to be exhaustive. The NPS confirms that impacts on equalities groups should be considered. See the *Equalities Impact Assessment* for further detail of how this requirement has been fulfilled.

10.3.3 Other relevant policy includes the adopted *London Plan 2011* (GLA, 2011)[2], borough *Unitary Development Plans* (*UDPs*) and *Local Development Framework*s (*LDF*) including *Core Strategy Development Plan Documents* (*DPDs*), both adopted and emerging. Relevant policies within these documents include those concerning public open space deficiency and accessibility criteria, child play space deficiency and accessibility criteria, and relevant site specific land use allocations.

10.3.4 Relevant guidance includes best practice guidance by the former Office of the Deputy Prime Minister on preparing neighbourhood baselines (2004)[3] and on reviewing employment land supply (Office of the Deputy Prime Minister, 2004)[4], Homes and Communities Agency guidance regarding employment density (2010)[5] and English Partnerships (2008)[6] and Scottish Enterprise (2008)[7] guidance regarding additionality[i].

10.3.5 presents the requirements within the NPS relevant to socio-economics and explains how the requirements have been addressed within the ES. The table also gives the location of the relevant material.

Vol 2 Table 10.3.1 Socio-economics – requirements of the NPS and how they have been addressed

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
Section 4.8 Land use including open space, green infrastructure and green belt		
4.8.5 The ES should identify existing and proposed land-uses near the project, any effects of replacing an existing development or use of the site with the proposed project, or preventing a	The socio-economic impact assessment has identified potentially sensitive receptors, including users of residential, commercial, recreational and institutional land and undertaken a socio-economic impact assessment where relevant. This has been undertaken for receptors that would be physically affected and for receptors within a distance up to 250m from the LLAU that could	Volume 2 Environmental assessment methodology, Section 10 Volume 3 Project-wide effect assessment, Section 10 Volumes 4 to 27

[i] Additionality can be defined as the additional impact that arises as a result of an intervention (ie, a project – in this case the Thames Tideway Tunnel) that would not have occurred in the absence of that intervention.

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
development or use on a neighbouring site from continuing. Applicants should also assess any effects of precluding a new development or use proposed in the development plan.	potentially experience amenity related effects. In doing so, the socio-economic impact assessment has had regard to the potential for project to significantly compromise, either directly or through amenity effects, the functioning of various types of land-uses, including dwellings, sensitive commercial businesses, schools, churches, recreational land uses such as parks and public rights of way (PRoW), and river related uses. Where known and relevant, the assessment has had regard to any potential future land uses that would be in place in the base case scenario.	(Site specific volumes)
4.8.6 **Applicants should use** any up-to-date local authority assessment or, if there is none, provide an independent assessment to show whether the existing open space, sports and recreational buildings and land is surplus to requirements.	Impact assessments of the project on recreational land uses, including public open spaces and PRoW have been conducted to assess the impact of physical impacts on public open space and recreational facilities and amenity related effects. In order to inform these assessments we had regard to the latest data publicly available from local authorities, such as public open space studies and assessments. In the case of the Barn Elms Schools Sports Centre, data has been obtained from the managing authority. Additionally, to inform the assessment process, usage surveys of selected public open space and associated recreational facilities, eg, the Thames Path, were conducted. The surveys were undertaken at a variety of different times including weekends and weekdays, both in and out of school term, and in summer	Volume 2 Environmental assessment methodology, Section 10 Volumes 4 to 27 (Site specific volumes including Appendix H.3 Baseline – open space usage surveys within the relevant site specific volumes[ii])

[ii] Barn Elms, Putney Embankment Foreshore, King George's Park, Falconbrook Pumping Station, Chelsea Embankment Foreshore, Albert Embankment Foreshore, Victoria Embankment Foreshore, Blackfriars Bridge Foreshore, Deptford Church Street, and King Edward Memorial Park.

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
	and autumn conditions. They surveys provided detailed information on the usage of facilities in order to help inform the assessments.	
4.15 Socio-economic		
4.15.2 Where the project is likely to have socio-economic impacts at local or regional levels, **the applicant should** undertake and include in their application an assessment of these impacts during the construction, operation and decommissioning phases.	The ES has considered socio-economic impacts at both the local and regional level during the construction and operation phases of the development. In relation to the decommissioning phase of the development, socio-economic impacts have not been considered or assessed. This is because the project has a design life of 100 years plus and it is would not be practical to undertake a robust assessment of the impacts so far into the future.	Volume 2 Environmental assessment methodology, Section 10 Volume 3 Project-wide effect assessment, Section 10 Volumes 4 to 27 (Site specific volumes; see in each volume Section 10.4 and Appendix H.1 Baseline community profile and Appendix H.2 Baseline economic profile)
4.15.3 **This assessment could** consider the following impacts, however these suggestions are not exhaustive and other socio-economic impacts should be	The assessment has considered impacts on: • Regional impacts associated with the creation of jobs and training opportunities. Effects have been considered at regional level rather than a local level because the project is located within Greater London and travel to work data	Volume 3 Project-wide effect assessment, Section 10 Volumes 4 to 27 (Site specific volumes; see in each volume Section 10.4 and Appendix H.1

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
assessed if appropriate for the proposed development: • Regional and local socio-economic impacts associated with new waste water infrastructure may include the creation of jobs and training opportunities. • The application should have taken into account the location of public rights of way, including footpaths, bridleways and byways and minimised hindrance to them where possible. • The changing influx of workers during the different construction, operation and decommissioning phases of the waste water infrastructure may alter the demand for services and facilities in the areas surrounding the proposed development.	from the 2001 census strongly indicates that Greater London largely operates as a single labour market area. As such, the regional area is the appropriate geographical level at which to assess the project. • Because London is a large city with a large and deep labour pool, it is anticipated that the project would not lead to an influx of workers during construction or operation. As such, it has not been considered necessary to consider the effect of any influx on the demand for services and facilities in the areas surrounding the proposed development. • The assessment has considered effects on public right of ways and footpaths, including specifically the Thames Path, Wandle Trail and Nation Cycle Routes where the construction sites interact with this infrastructure. On the basis that the list in the NPS is not exhaustive, the assessment has also looked at effects on other potentially sensitive receptors including residential, commercial, recreational, and institutional land uses and activities and the receptors associated with each of those where applicable.	Baseline community profile and Appendix H.2 Baseline economic profile)

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
4.15.4 **Applicants** should describe the existing socio-economic conditions in the areas surrounding the proposed development and could also refer to how the development's socio-economic impacts correlate with local planning policies.	The assessment has described the local context, local community profile (socio-economic and demographic) and local economic profile (jobs and businesses) of the areas surrounding the proposed development sites. This has included a comparison with reference the local authority and Greater London overall. This has been completed at the project-wide level and at a site specific level Wherever relevant, the assessment has had regard to how socio-economic impacts correlate with local planning policies; including planning policy on designated employment land and open space provision.	Volume 3 Project-wide effect assessment, Section 10 Volumes 4 to 27 (Site specific volumes; see in each volume Section 10.4 and Appendix H.1 Baseline community profile and Appendix H.2 Baseline economic profile)
4.15.5 Socio-economic impacts may be linked to other impacts, for example the visual impact of a development is considered in (Section 4.7) but may also have an impact on tourism and local businesses.	The socio-economic assessment has included a comprehensive assessment of the potential for visual, air quality, construction dust, noise and vibration effects to impact effects on the amenity of sensitive receptors, including residential receptors, schools, churches, public open spaces and recreational resources such as the Thames Path, and potentially sensitive commercial receptors such as restaurants and hotels. In doing so, the assessment has also had regard to the potential for the assessment to impact on local businesses and tourism. Consideration of the potential impact on tourism has been undertaken at Victoria Embankment Foreshore and also at a project-wide level. Consideration of the impact on businesses has also been undertaken where the proposed works would either physically interact with or potentially displace an existing business.	Volume 2 Environmental assessment methodology, Section 10 Volume 2 Appendices: Environmental assessment methodology, Appendix H Volumes 4 to 27 (Site specific volumes; see in each volume Section 10.6)

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
4.15.6 **The applicant** should undertake and include in their application an equalities impact assessment for the construction, operation and decommissioning phases.	The applicant has undertaken an *Equalities Impact Assessment* (*EqIA*) independent of the socio-economic impact assessment and this constitutes part of the application. The socio-economic impact assessment has shared baseline data with the *EqIA* to ensure consistency.	*EqIA*
4.15.10 **The decision maker** should have regard to the potential socio-economic impacts of new waste water infrastructure identified by the applicant and from any other sources that it considers to be both relevant and important to its decision. It should be reasonable for **the decision maker** to conclude that little weight is to be given to speculative assertions of socio-economic impacts not supported by evidence (particularly in view of the need for waste water infrastructure as set out in this NPS).	The information required for the decision maker to have regard to the potential socio-economic impacts can be found in the project-wide effect assessment report and the respective site specific volumes.	Volume 3 Project-wide effects assessment, Section 10 Volumes 4 to 27 (Site specific volumes; see in each volume Section 10.5, 10.6, 10.9 and 10.10.)

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
4.15.12 **The decision maker** should consider whether the mitigation measures put forward by the applicant are acceptable, for example in order to mitigate any adverse socio-economic impacts of the development.	The information required for the decision maker to have regard to the mitigation measures put forward by the applicant can be found in the respective site specific volumes. The decision maker should refer specifically to the sections of the socio-economic assessment relating to mitigation, and also to the sections concerning air quality and odour, noise and vibration and townscape and visual assessments concerning mitigation, as these topics have informed the amenity effect assessments contained within the socio-economic assessments.	Volumes 4 to 27 (Site specific volumes; see in each volume Section 10.8, and also Section 4.8, Section 9.8 and Section 11.8.)

10.4 Baseline data collection

10.4.1 In order to assess potential socio-economic effects, the relevant baseline conditions have been identified and considered.

10.4.2 Baseline data have been collected and presented to establish the existing site specific context and conditions in relation to the following overriding themes:

a. the local socio-economic conditions at each site (ie, undertaken by statistically profiling the local community and economy at each site; see Vol 4-27 Appendix H.1), the 13 boroughs containing proposed construction sites and for Greater London

b. economic infrastructure (eg, places of employment and businesses)

c. recreation and social infrastructure (eg, public open spaces, facilities and services)

d. amenity (eg, within the local environment such as residential amenity, public open space amenity, etc).

10.4.3 Data have been collected at different spatial levels according to the nature of the potential effect to be assessed and the baseline indicator in question.

10.4.4 Data and information included within this assessment in relation to these socio-economic themes have been obtained from a wide range of sources including desk-based research, field surveys and consultation undertaken by Thames Water with businesses, public sector bodies and community organisations as described in para. 10.2.9.

Desk based baseline data

10.4.5 The analysis of baseline conditions is primarily desk-based and has been carried out using a number of recognised data sources. These are listed in Vol 2 Table 10.4.1.

Local context data

10.4.6 In order to establish an appreciation of the local context at each site and for Greater London overall, local community profiling and local economy profiling exercises have been undertaken by collecting and presenting relevant demographic, socio-economic, and business and employment data. The data that have been presented at the relevant area of statistical detail / aggregation, usually within a local context reflecting the potential impact area.

10.4.7 The community profile data have been collected in tandem with the *Equalities Impact Assessment* (which accompanies the application). The *Equalities Impact Assessment* has identified those equalities groups that are disproportionately represented within 250m and 1000m[iii] of the site (as represented by the limits of land to be acquired or used [LLAU]). These data have been collected so as to ensure consistency between the baseline used in the socio-economic assessments and in the *Equalities Impact Assessment* which has been undertaken for the project (see Vol 4-27 Appendix H.1).

10.4.8 Data on economic activity have been collected and presented at the local and regional level in order to set out the economic context of the Thames Tideway Tunnel project sites (see Vol 4-27 Appendix H.1).

Receptor related data

10.4.9 Information related to the provision of a social infrastructure facility or service was usually collected and analysed within the context of local provision.

10.4.10 Amenity related baseline conditions are presented within the context of the site, its existing functions and its surroundings as determined by the physical layout of development and potential receptors.

10.4.11 The baseline analysis has included a review and consideration of planning policy and site specific allocations, as appropriate and at various levels including locally (borough) and regionally (Greater London). Documents that have been reviewed include:

a. London borough LDFs including core strategy documents and proposals maps (or saved local plan policies, if applicable)

b. London borough employment land reviews and the London 2010 Industrial Land Baseline

c. London borough open space (and or including Child Play Space) assessments and audits.

[iii] These two data collection areas allow for the identification of community profiles that reflect the immediate surroundings of the proposed construction sites and the wider local areas.

Data sources

10.4.12 The data sources used for this assessment are set out in Vol 2 Table 10.4.1. Each dataset provides a snapshot of a certain point in time, depending on the date at which it was collected. This date, and the associated baseline year, varies depending on the data source in question. The date of the data is given in the table where relevant.

10.4.13 In addition to the data sources listed in Vol 2 Table 10.4.1, web-based research has been undertaken to provide supplementary information, for example for information on developments nearby or to check the location, opening hours and capacity of local community facilities. Where relevant, references are attached to the sources listed in Vol 2 Table 10.3.1.

Vol 2 Table 10.4.1 Socio-economics – desk based baseline data sources

Source	Data
Annual Population Survey (2012)[8]	Borough level occupation profile
Census of Population (2001)[9]	Travel to work area (TTWA); Population; Gender; Age; Ethnicity and Religion
Construction Statistics Annual (2010)[10]	Number of construction workers in Greater London
Department for Communities and Local Government – Index of Multiple Deprivation (2010)[11]	Data on income deprivation and overall deprivation
Department for Education (2011)[12]	School census data by establishment
Experian (2012)[13]	Number and type of businesses and employees in the local area
Glenny Databooks (various dates)[14 & 15]	Information on industrial floorspace vacancy
Green Flag Awards website[16]	Information about the Green Flag award scheme
Greater London Authority – *London's Economy Today* 119 (2012)[17]	Growth and output in the Greater London economy
Greater London Authority – *Green infrastructure and open environments: The All London Green Grid Supplementary Planning Guidance (2012)*[18]	Quantitative information on the amount of open space (over 1ha in size) in Greater London
London Development Agency – *London's Industrial Land Baseline* (2010)[19]	Quantitative information on employment land supply and vacancy
London Parks and Gardens	Qualitative information on parks and

Source	Data
Trust – London Gardens Online (dates vary by site)[20]	open spaces
London Plan 2011– The Spatial Development Strategy for Greater London (2011)[21]	Open Space Hierarchy and Accessibility Criteria
London Public Health Observatory (2012)[22]	Data on life expectancy
London Borough (LB) of Ealing – *Ealing Green Space Strategy* 2012-2022 (2011)[23]	Qualitative information on parks and open spaces
LB of Hammersmith and Fulham *Employment Land Assessment – Updating Statement* (2010)[24]	Employment land and floorspace supply and vacancy
LB of Hammersmith and Fulham *Environment and Planning – Parks and open spaces*[25]	Qualitative information on parks and open spaces
LB of Hounslow – *London Borough of Hounslow Employment Land Review* (2011)[26]	Employment land and floorspace vacancy
LB of Lewisham – Conservation Sites[27]	Qualitative information on open spaces
LB of Lewisham Core Strategy Development Plan Document (2011)[28]	Information on site-specific allocations and planned developments adjacent to Earl Pumping Station site
LB of Lewisham Employment Land Study (2008)[29]	Information on employment land and floorspace supply
LB of Lewisham Open Spaces Strategy (2010)[30]	Open space deficiency levels
LB of Richmond upon Thames - Core Strategy (2009)[31]	Information on open space provision
LB of Richmond upon Thames– *Sport, Open space and Recreation Needs Assessment* (2007)[32]	Information on parks, open spaces and sports facilities
LB of Southwark Open Space Study (2010)[33]	Qualitative information on parks and open spaces
LB of Tower Hamlets Open Space Strategy[34]	Deficiency area of local parks and open space
LB of Tower Hamlets King	Quantitative, qualitative and

Source	Data
Edward Memorial Park management plan 2007-17 (2008)[35]	management information on the open space
LB of Wandsworth Barn Elms Boathouse information page (2012)[36]	Quantitative, qualitative and management information on the open space
LB of Wandsworth Core Strategy Development Plan Document (2010)[37]	Deficiency area of local parks
LB of Wandsworth Employment Land and Premises Study (2010)[38]	Employment floor space supply and vacancy
LB of Wandsworth Open Space Study (2007)[39]	Qualitative data on local open space
LB of Wandsworth Technical Services Unit (correspondence April 2011)	Use of and facilities at Barn Elms Schools Sports Centre
National Health Service – General Practitioner (GP) Surgeries (2012)[40]	Directory of GP surgeries
Network of Public Health Observatories (2011)[41]	Health profiles by borough with data on rates of physical activity, adult and child obesity and mortality rates
Office for National Statistics (ONS) – Commercial and Industrial Property Vacancy Statistics (2005)[42]	Information on floorspace vacancy
ONS Labour Market Statistics (2012)[43]	Unemployment and employment levels in Greater London and nationally
Royal Borough (RB) of Kensington and Chelsea Core Strategy Development Plan Document (2010)[44]	Information on site-specific allocations and planned developments adjacent to RBKC sites
RB of Kensington and Chelsea (website) – Parks and Gardens (2012)[45 & 46]	Operational information on parks and gardens
Thames Recreational Users Study (2007)[47]	Operational information
Thames Tideway Tunnel – *River Usage Survey (*2012)[48]	Boat and pedestrian activity in the proximity of specific worksites
Transport for London (2012)[49]	Information on river services, passenger numbers and timetables on the River

Source	Data
	Thames
Visit Britain – *Inbound Visitor Statistics* (2012)[50] Foresight Issue 100 (2012)[51]	Current and future visitor numbers in London

Field survey baseline data

10.4.14 Visits have been made to all sites, comprising a walkover of the site and adjacent areas, if likely to be potentially affected. Observations were made of key site characteristics, features, potentially sensitive receptors, and the general level of amenity experienced by receptors surrounding the sites.

10.4.15 Primary research, involving field based usage surveys of public open spaces and recreational facilities, was undertaken during 2011 and 2012 in order to examine the usage levels of these potentially affected public assets. The data collected augment the desk top information that has been collected.

10.4.16 The usage surveys focused on counting the number of users of public open spaces, according to the type of activity being pursued, at specific locations appropriate to each survey area. The methodology employed for these surveys is explained in detail in Vol 2 Appendix H.3 and the survey findings are appended to each site volume.

Receptor identification and sensitivity

Receptor identification

10.4.17 The baseline has identified potentially sensitive receptors and considered their sensitivity to the impacts that would arise as a result of the proposed development.

10.4.18 In the socio-economic context, receptors are individuals, organisations or groups (for example, open space users, residents, businesses and their employees, workers within a given labour force area or industry sector, residents, etc) who are users or beneficiaries of socio-economic resources, assets and facilities which may be affected by the proposed development. Receptors and resources would vary for each type of impact and effect and may vary from site to site.

10.4.19 Users of employment land have also been identified as a socio-economic receptor for the purpose of this assessment, because land designated for employment related land uses represents an important resource for businesses and is an important element of the economic infrastructure which is required for business activity and employment generation.

10.4.20 A receptor can experience a socio-economic impact in several different ways:

a. As an economic / financial gain or loss.

b. As a gain or loss of a resource or access to a resource.

c. As a gain or loss of amenity, including that which is derived from, or experienced while using, a resource such as a public open space or library.

10.4.21 Accordingly, receptors which could experience a socio-economic impact in one or more of these ways as a result of the Thames Tideway Tunnel project have been identified and described in the baseline section of the site-specific volumes.

Business receptors

10.4.22 For the purpose of the socio-economic assessment a business receptor has been defined as a business and the employees associated with that business.

10.4.23 Businesses have been classified as equivalent to a micro, small, medium or large[iv] sized enterprise based on the number of workers known or estimated to be employed on site in accordance with the definitions used by the Department for Business Innovation and Skills (2011)[52]. The categories for these classifications are as follows:

a. Micro 1-9 employees

b. Small 10-49

c. Medium 50-249

d. Large 250+ employees

10.4.24 Where possible information has been obtained through engagement with the potentially affected business. Where this has not been possible the number of workers has been estimated based on the floorspace of the business and the nature of the business activities.

Identifying receptors for assessment of amenity effects

10.4.25 The amenity assessment considers mostly unscreened[v] receptors that are located up to a maximum of 250m from the LLAU and for which it has been found that they would be subject to one or more significant residual effects in respect of the air quality, construction dust; noise, vibration (human response); and visual assessments (assessed in their own right in other sections of the *Environmental Statement*)[vi].

10.4.26 The types of receptors that have been identified are:

a. public open spaces

b. recreational facilities

[iv] All of the businesses assessed fall within the micro, small or medium size categories; ie, there were no 'large' size businesses identified for assessment as receptors.

[v] The amenity effect assessments are informed by the noise and vibration, air quality and visual impact assessments, all of which largely consider unscreened receptors. As such, most socio-economic receptors identified for assessment of effects on amenity are unscreened.

[vi] The residual effects are used as they reflect the final conclusion of the other topic assessments, taking on board all mitigation measures proposed. As such, the residual findings represent the most likely outcomes for affected receptors. In turn, this allows for the amenity effect assessments to be informed by the most likely outcome and is considered to be the most robust approach. In addition, it allows for the amenity assessments to be presented clearly and concisely to the benefit of those reading this Environmental Statement.

c. community facilities

d. residential receptors

e. businesses.

10.4.27 Businesses which have been identified are those that would be sensitive to a reduction in amenity due to air quality, construction dust, noise, vibration or visual effects such as hospitality sector businesses including bars, pubs, cafes, restaurants, hotels and conference centres; audio / visual recording studios; and certain retail businesses. Amenity effects were not considered for industrial, warehouse or office based businesses unless exceptional circumstances apply[vii]. In those cases for which exceptional circumstances apply, the receptor has been identified within the relevant site specific report.

10.4.28 To inform this process the scoping results and effect assessment results of the air quality, construction dust, noise, vibration (human response) and visual impacts assessments have been reviewed and the receptors identified by each topic have been cross checked[viii]. Some receptors identified in the air quality, construction dust, noise or vibration (human response) assessments have not been explicitly identified in the visual impact assessment as a viewpoint. In these circumstances, in liaison with the townscape and visual assessors, nearby suitable alternative viewpoints of an appropriate nature have been identified which can be relied upon to inform the assessment and this has been explained in the relevant site assessments.

10.4.29 In some cases, there may be more than one of a certain type of receptor (eg, open spaces) within 250m of the site. Where this occurs, the assessment primarily concentrates on those receptors closest to the main construction site which would generally be most affected, rather than those further away which would be screened by intervening buildings. In such cases, usually only the receptor which is closest to the proposed construction site has been assessed. Effects at more distant receptors beyond those closest to the site have been considered where necessary by reference to the impacts determined at the primary receptors.

Determining receptor sensitivity

10.4.30 The sensitivity of a socio-economic receptor can vary according to the type of receptor. For socio-economic receptors, sensitivity broadly concerns the availability of alternatives (ie, resources) and the capacity of a receptor to absorb or cope with change brought about by the impact. The way in which these factors are manifest will vary depending on the

---

[vii] Industrial, warehousing, and office based businesses have generally not been considered unless exceptional circumstances apply because of a prediction that there would be prolonged and highly disturbing air quality, construction dust, noise, vibration (human response), and/or visual effects.

[viii] Where these assessments have identified one or more major, moderate, or minor adverse effects (or one or more significant effects, in the case of those topics which do not utilise a ‘major, moderate, minor and negligible’ effect register to assess the significance of effects), the receptor has been included as a receptor in this assessment, and an assessment has been made of the potential significance of the resulting amenity effect from a socio-economic amenity perspective.

type of receptor. Sensitivity has therefore been considered in the following ways.

Sensitivity of individuals and groups

10.4.31 The sensitivity of a receptor, where that receptor is an individual or group, has been determined by consideration of the following factors:

a. The value of an affected resource to the user.

b. The scarcity of a resource from which the receptor derives benefit (such as a park or leisure route providing for recreation) and the availability of comparable alternatives within a reasonable accessible distance (ie, as determined by the catchment area or spatial significance[ix] of the resource from which the receptor derives benefit).

c. The receptor's capacity to experience a loss or gain of that resource.

Sensitivity of businesses

10.4.32 The sensitivity of a receptor, where that receptor is a business and its employees, is determined by consideration of the following factors:

a. The degree to which a business depends on its location in terms of supply side factors (eg, land-intensive operations may require a sufficiently large site or a river-transport dependent operation may require good access to a dock or wharf).

b. The degree to which a business depends on its location in terms of demand side factors (eg, whereby the business derives a substantial portion of its business due to its location).

c. The uniqueness or degree of specialisation of the business (eg, if that business were to close, is there an alternative resource which customers could access).

d. The availability of alternative sources of employment (itself a combination of the transferability of a worker's skills and the size and general economic health of the relevant respective industry sector(s) in which workers would find alternative employment).

Sensitivity of receptors to amenity effects

10.4.33 In addition to the factors listed above, in terms of amenity effects (caused by air quality impacts, construction dust, noise, vibration [human response] and visual impacts) the sensitivity of a receptor (such as residents, open space users, community facility users, students and teachers of a school, and businesses) has also been determined by consideration of the following factors:

a. The relationship between a resource and / or a receptor and the environmental conditions, such as the level of tranquillity required for the receptor to enjoy the benefits offered by a resource. This includes

---

[ix] A resource may be locally, regionally or even nationally significant reflecting the catchment area from which it draws users. For example, the GLA Open Space Hierarchy (2011) classifies open spaces by size and identifies the typical catchment area to which different size public open spaces cater, thereby indicating its spatial significance.

the degree to which people (the receptors) are already accustomed to existing levels of amenity effects.

b. The type of activity being undertaken and the overall external environmental amenity conditions / level of tranquillity required for the receptor to be able to undertake and enjoy that activity.

   i For example, residential receptors would be likely to be more sensitive to significant construction / traffic noise or construction site lighting at night because of the potential for disturbance to sleep patterns, but would on average be generally less sensitive to an equivalent level of construction / traffic noise or lighting during the day. For this reason, residents would have medium sensitivity to amenity effects overall during the day[x] but would have high sensitivity to significant noise and / or visual effects during the evening[xi] and night[xii].

   ii Similarly, it is considered that residential receptors would have high sensitivity in any situation where significant adverse noise or amenity effects resulted in the residential receptor becoming eligible for and taking up temporary re-housing.

10.4.34 Due to the factors set out in para. 10.4.31, para. 10.4.32 and para. 10.4.33, the level of sensitivity of a given receptor identified within the socio-economic amenity impact assessment may not always be consistent with the level of sensitivity assigned to that same type of receptor in the air quality, construction dust, noise, vibration (human response) and / or visual impact assessments. For instance, the visual impact assessment assumes low sensitivity for active sports, but the socio-economic assessment often assumes a medium sensitivity for users of active sports facilities within open spaces in cases where there is a limited availability of comparable alternative such facilities or open spaces within a reasonably accessible distance (eg, users of the Barn Elms Schools Sports Centre).

10.4.35 This difference also arises in certain cases as a consequence of the fact that the level of sensitivity assigned to a given type of receptor can vary between the air quality, construction dust, noise and vibration, and visual impact assessments because of the different considerations that are relevant to those respective topics. In such cases, the level of sensitivity assigned to a receptor by the socio-economic assessment has differed from the level assigned by at least one of the other topics whose results feed into the amenity effect assessment.

10.4.36 Further detail on the range of interacting factors and circumstances relevant to amenity effects is given in Vol 2 Appendix H.4.

---

[x] From 0700 to 1900 on a weekday and 0700 to 1300 on Saturday (as indicated in Section 8 Noise and vibration).

[xi] From 1900 to 2300 on a weekday, 1300 to 2300 on Saturday and 0700 to 2300 on Sunday (as indicated in Section 8 Noise and vibration).

[xii] From 2300 to 0700 (as indicated in Section 8 Noise and vibration).

Summary

10.4.37 The sensitivity of receptors has been identified on a site by site basis with reference to the above considerations, making reference to relevant guidance where applicable and / or employing professional judgement. The sensitivity ascribed to receptors at each site is explained in the baseline section of each respective site specific assessment. The receptor sensitivity criteria are summarised as presented in Vol 2 Table 10.4.2.

Vol 2 Table 10.4.2 Socio-economics – receptor sensitivity criteria

Receptor sensitivity	Definition
High	Individuals, businesses or groups that highly value a resource and / or are likely to be particularly sensitive to a given impact.
Medium	Individuals, businesses or groups that place an average value on a resource and / or are likely to be moderately sensitive to a given impact.
Low	Individuals, businesses or groups that place a low value on a resource and / or are likely to have a low sensitivity to a given impact.

Base case

10.4.38 The likely significant effects of the construction and operation of the Thames Tideway Tunnel project have been assessed against the base case in a given assessment year. The base case for assessment is a scenario in the future (in a given assessment year) without the project.

10.4.39 Whilst the baseline data which have been collected form a ‘current baseline’, the base case allows consideration of how the baseline environment is likely to change, in the absence of the project. Changes to the base case could include the opening or closing of residential developments, businesses or social infrastructure, a change in local resident population due to natural growth or migration, and / or changes in the demographic and socio-economic profile of a community as the age, relative health, relative affluence, etc, of people within that community changes.

10.4.40 The base case has been predicted as an input to the subsequent assessment. This has been achieved by having regard to information such as published draft and approved planning policy, the site development schedules (see Appendix N in Vol 4-27), project-wide development schedules (see Appendix A.1 in Vol 3) and published forecasts for employment, community and economic data for the project-wide assessment.

10.5 Construction effects assessment

Assessment years

10.5.1 The construction assessment year for the purposes of site specific socio-economic assessments is the peak year of construction at each site.

10.5.2 The following caveats that apply are:

a. It is often relevant in the assessment of socio-economic effects to take the duration of the impact into account, eg, when considering the effect on a receptor arising from the partial or full closure of a facility, diversion of a public right of way, or the length of time for which receptors may be subject to amenity related effects; as the length of time may affect the overall magnitude of the impact. For each assessment for which duration is a relevant consideration, it has been clearly presented amongst the factors relevant to the assessment of the magnitude of impact.

b. Where the assessment has considered potential overall amenity effects arising as a result of air quality, construction dust, noise and vibration (human response), and visual impacts, the respective peak years of these effects may differ. For example, the air quality impact assessment is based on the peak year of construction, whereas the construction dust assessment can be extrapolated across the whole construction period. The noise assessments are based on a month-by-month modelling of the expected noise impacts arising during the construction period. The visual assessment is also based on the peak year of construction, although at many sites it is likely that the effects observed in the peak year would be observed in other years during the construction phase. For this reason the assessment year(s) for the amenity assessment have had to be informed by the assessment years for the respective effects, and the duration of any significant effects, where known.

c. The socio-economic assessment includes consideration of the effects of temporary re-housing at two sites where residents may be eligible for and take up temporary re-housing. The assessment considers the effect of this re-housing on the receptor in terms of the periods of time when temporary re-housing would take place, irrespective of whether or not this would occur during the peak year in order that the effect of re-housing on the receptor is not underestimated.

d. Consideration is given to the extent to which the construction assessment findings would be likely to vary materially from those assessed should the programme for the Thames Tideway Tunnel project be delayed by approximately one year. At the majority of sites the base case would be considered to remain the same should there be a delay of one year. Exceptions to this are at sites where cumulative developments (or phases thereof) would have been completed during this timeframe. The sites at which this assessment has been applied are:

   i Cremorne Wharf Depot

ii Greenwich Pumping Station

iii Hammersmith Pumping Station

iv Heathwall Pumping Station, and

v Kirtling Street

Assessment areas

10.5.3 For socio-economics the assessment area must be considered in two ways:

a. The impact study area; ie, the area within which the assessment has identified resources or receptors that could be affected by the project.

b. The geographical area of the effect; ie, the area within which a receptor could be affected by the impact as determined by the size of the economy in which a given business operates, the size of the relevant labour market (ie, the travel to work area), and / or the distance from which people typically travel to access and use a resource or facility (ie, the catchment area).

Impact study area

10.5.4 The assessment has considered impacts on any socio-economic resource or receptor that lies partly or wholly within the LLAU and which would be physically affected by the project, and / or any other receptor which would be physically affected by the project due to its proximity to the project.

10.5.5 For the amenity related effect assessment, the assessment has considered impacts on socio-economic resources and receptors which are located up to 250m from the LLAU and which are also located on the same side of the River Thames. This distance is based on an average of the assessment areas for other relevant environmental effect topics (air quality, construction dust, noise, vibration [human response] and visual impacts) and represents a distance at which findings by all of these topics are generally consistently available.

Geographic areas of effect

10.5.6 The geographical area of effects would vary depending on the nature of the impact in question and the receptors that may be affected. For example, impacts on social infrastructure are likely to affect users within the catchment area of the resource or service and could range from within 400m of the resource or facility to several kilometres.

10.5.7 The various geographical areas of effect / catchment area and associated rationale are set out in detail below in Vol 2 Table 10.5.1.

Vol 2 Table 10.5.1 Socio-economics – site specific geographical areas of effect

Impact	Geographical area of effect / catchment area	Rationale

Impact	Geographical area of effect / catchment area	Rationale
Impact on businesses (eg, displacement or effects arising due to construction related amenity impacts)	Business specific (including employees of the business)	Professional judgement
Impact on employment land	Borough level and / or sub-regional level	ODPM, Employment Land Reviews: *Guidance Note 2004*
Impact on open space users – pocket parks (>0.4ha) and small open spaces (>2.0ha)	Radius of up to 400m from the open space	GLA, *London Plan 2011*, Open Space Hierarchy
Impact on open space users – local parks and open spaces (2ha)	Radius of 400m from the open space	GLA, *London Plan 2011*, Open Space Hierarchy
Impact on open space users – district parks (20ha)	Radius of 1.2km from the open space	GLA, *London Plan 2011*, Open Space Hierarchy
Impact on linear open space users	Radius of up to 1km, or greater where applicable, from the zone of impact on the open space	GLA, *London Plan 2011*, Open Space Hierarchy / Professional judgement
Impact on child play space provision – for under 5 year olds	Radius of up to 200m from the child play space	GLA, Providing for Children and Young People's Play and Informal Recreation SPG, 2008
Impact on child play space provision – for 5 to 11 year olds	Radius of up to 800m from the child play space	GLA, Providing for Children and Young People's Play and Informal Recreation SPG, 2008
Impact on child play space provision – for 12 years and over	Radius of up to 1.6km from the child play space	GLA, Providing for Children and Young People's Play and Informal Recreation SPG, 2008
Impact on public rights-of-way (eg, Thames Path) users	On-site / convenient walking distance (up to 1km), from the point or zone of impact along	GLA, *London Plan 2011*, Open Space Hierarchy / Professional

Impact	Geographical area of effect / catchment area	Rationale
	the public right of way	judgement
Impact on river space	Determined based on physical extent of recreational or commercial use at each site	Spatial incidence of recreational or commercial activities
Impact on social infrastructure provision	Determined based on modes of access and respective travel times at each site	Local policy and guidance / Professional judgement
Impacts on recreation, leisure, tourism	Determined based on modes of access and respective travel times	Local policy and guidance / Professional judgement

Methodology

10.5.8 The assessment seeks to establish the net potential economic and social effects of the project. The effects of the project are considered at varying spatial levels according to the nature of the effect considered, through comparison of the development (in a specified assessment year) with a base case scenario, consistent with relevant guidance as set out in Section 10.3.

10.5.9 In most cases, the site specific nature of effects, the distance between proposed construction sites, and the assessment areas applicable to the consideration of socio-economic effects are such that effects on receptors at neighbouring or multiple sites do not overlap. The single exception is with regard to effects on users of the Thames Path as a result of diversions. In this case, in the absence of guidance from the GLA or other agencies, professional judgement has been employed to establish criteria for the consideration of overlapping effects on Thames Path users; whereby consideration has been given to effects on users of the Thames Path where users would experience adverse effects at two or more sites within a distance of approximately 1,500m (eg, as has been assessed to be the case at Victoria Embankment Foreshore and Blackfriars Bridge Foreshore).

Economic effects, including effects on businesses

10.5.10 The nature of the proposed works means that effects on businesses are likely to take two key forms:

a. Displacement; whereby a business would be physically displaced from its base case location as a result of the proposed works.

b. Amenity effects; whereby a business unit would be likely to suffer a loss of trade compared to the base case scenario due to effects on the amenity of the surrounding area that occur as a result of the proposed works.

10.5.11 The various factors influencing effects on a business are weighed up in a logical and consistent way, drawing on information derived from consultation and desk-based research, and professional judgement.

10.5.12 The assessment of effects on a business has focused exclusively on the business unit that is immediately affected at that location and the employees that work at that location. Where that business is a branch or subsidiary of a larger enterprise with operations at other locations, it has not considered the effect on those other parts of the enterprise.

10.5.13 Effects on businesses as a result of a temporary or permanent loss of parking are considered within Section 12 Transport.

Effects on social infrastructure

10.5.14 The definition of social infrastructure provided by the *London Plan 2011* has been applied, whereby social infrastructure "covers facilities such as health provision, early years provision, schools, colleges and universities, community, cultural, recreation and sports facilities, places of worship, policing and other criminal justice or community safety facilities, children and young people's play and informal recreation facilities". Informal recreational facilities are considered to include open spaces and public rights of way.

10.5.15 The assessment of effects on social infrastructure has focused on the user of that infrastructure and the degree to which a loss of access or reduction of amenity for users would affect them.

10.5.16 In both cases, the assessment has considered the function of the social infrastructure in question and the availability of alternatives which are practically and conveniently accessible given the typical catchment area for the facility in question (as defined by relevant guidance or professional judgement).

10.5.17 With regard to users of the Thames Path and certain other public rights of way / trails (eg, Wandsworth Trail, Queen Elizabeth Walk, and Beverley Brook Walk), the socio-economic effects assessment has been primarily focused on the functionality of these routes as recreational facilities.

10.5.18 The traffic and transport assessment considers pedestrian amenity, whereby the impact has been defined in terms of the project's potential to close pedestrian routes or footpaths or narrow a route below certain thresholds (see Table 12.5.3 in the Transport methodology within this volume). This is different to the socio-economic amenity assessment, which considers the effect on users relating to potential amenity effects caused by air quality, construction dust, noise, vibration (human response) and visual impacts, and the degree to which this could impair a public right of way's recreation / leisure / tourism functionality for users.

Effects on amenity

10.5.19 The amenity effect assessments relate to air quality, construction dust, noise, vibration (human response) and visual impacts; and the potential for these effects to influence the amenity (ie, the enjoyment of a place or environment) experienced by a receptor.

10.5.20 The assessments have been undertaken to consider the potential effect on receptors that would arise as a result of construction activity at individual sites. The assessment has been undertaken as representative of worst case scenarios such as for those receptors which are closest to the site, for those times of day or night when receptors would be at their most sensitive (eg, noise effects on a residential receptor), or at the time of year when effects such as visual effects would be most apparent.

10.5.21 There is no existing framework or best practice guidance for considering such effects. Further, there are a range of complex human, social and economic factors that can be involved in considering the potential for such impacts to affect amenity. For these reasons, it has not been possible to assess amenity effects quantitatively.

10.5.22 Instead, an assessment guidance framework has been developed which has been partly informed by on an approach advocated by the Environment Agency for considering the factors that can contribute to the degree of odour pollution experienced by a receptor. This approach is known as FIDOR (or FIDOL by some other agencies); which stands for frequency, intensity, duration, offensiveness and 'receptor sensitivity' (or simply 'location') (EA, 2011)[53]. As the amenity assessment considers the potential for up to five different types of effects to impact on amenity, the assessment has also given consideration to the likelihood for the different amenity related impacts to occur simultaneously. See Vol 2 Appendix H.4 for further detail regarding the assessment guidance framework that has been used.

10.5.23 The sensitivity of the receptor has been considered as described in the baseline. However, as indicated by the FIDOR approach, the interaction of the above factors and the way in which they influence amenity is variable and dependent on the particular circumstances at each site and affecting each receptor, including its context and its susceptibility to different types of amenity related effects.

10.5.24 As such, the socio-economic assessments of amenity effects have been undertaken with direct reference to the residual effects assessment results of the air quality, construction dust, noise, vibration (human response) and visual topics (see para. 10.4.25), as well as any other relevant factors that could also affect the amenity of a place or a residential, commercial or recreational (eg, open space, public right of way) environment.

10.5.25 Further, where significant noise effects on residential receptors have been identified within the noise assessment as a result of noise exceedances during the evening and / or night, the assessment has been carried out on the basis of the residential receptor having a high level of sensitivity. If this is not the case, the assessment of residential receptors has been carried out on the basis that the residential receptor has medium level of sensitivity to the amenity effects under consideration.

10.5.26 Each assessment has been undertaken using professional judgement and the logic has been explained within each assessment. There are certain common considerations that generally apply for different types of receptor.

10.5.27 While each of these other assessments has used the peak year of construction as its assessment year, the noise assessment in particular has presented information within its appendices to each site volume (Vols 4-27) to indicate the duration of significant adverse noise effects. This information has been taken into consideration in assessing the magnitude of impact alongside other factors (see para. 10.5.32).

Effects on residents who take up the option of temporary re-housing

10.5.28 The nature of the proposed works means that temporary re-housing eligibility thresholds may be exceeded at some sites, and affected households may be eligible for temporary re-housing during certain periods of the construction phase.

10.5.29 The various factors influencing effects on residents (ie, residential households) in the event of being temporarily re-housed are weighed up in a logical and consistent way, drawing on information derived from the amenity-related topic assessments (ie, the likely duration of relocation required) and professional judgement.

10.5.30 The assessment of effects on a household of temporary re-housing has focused exclusively on the household unit that would be immediately affected if they were temporarily re-housed. It takes account of the fact that it is possible that some households may include residents that stay at home or work from home during the day. It also takes into account the duration of the temporary re-housing period and whether it is greater than one month, the nature of the temporary accommodation, whether the temporary re-housing is beyond walking distance (considered to be up to 800m to 1km) from the relocated households' usual place of residence, and the inconvenience caused to residents.

Significance criteria

10.5.31 The likely significant effects on socio-economics have been determined with reference to the guidelines published by the Homes and Communities Agency, English Partnerships, the Mayor of London, the Environment Agency and relevant local authorities (see para. 10.3.3 and 10.3.4, and also Vol 2 Table 10.4.1 and Vol 2 Table 10.5.1). The level of significance of an effect has been derived from a measure of the magnitude of impact and the sensitivity of the receptor affected as described below.

Determining magnitude of impacts

10.5.32 The magnitude of an impact is its severity or scale. The magnitude of an impact on a receptor reflects consideration of information and analysis relating to:

a. Spatial extent of the effect (localised / isolated versus widespread, having regard to published standards [where existing] on the geographical effect area / catchment area of the affected resource or receptor, as identified in Vol 2 Table 10.5.1).

b. Extent (number of individuals, groups, households and / or businesses affected).

c. Duration (short term - less than 12 months, medium term - 1–5 years and long-term - more than 5 years).

d. Conformity with standards for provision or accessibility (as set out in regional or local planning guidance).

e. Permanency of the impact.

f. Likelihood of impact occurring.

g. Value of the resource to users.

10.5.33 The complexity of interactions between these factors when impacting on socio-economic receptors means that it has not been considered appropriate to set out precise quantitative measures. However, the assessment process has ascertained information in respect of the above factors and professional judgement has been employed to evaluate the magnitude of the impact.

10.5.34 The professional judgement employed has been guided by the criteria presented in Vol 2 Table 10.5.2.

Vol 2 Table 10.5.2 Socio-economics – impact magnitude criteria

Impact magnitude	Definition
High	An impact that would be very severe / beneficial and / or very likely to affect large numbers of people and / or groups, usually at a London-wide or sub-regional level and / or which would usually continue beyond the project life and effectively constitute a permanent, long-term impact on the base case conditions.
Medium	An impact that would be moderately severe / beneficial and / or likely to affect a moderate number of people and / or groups, usually at the district or borough level , and / or which would usually continue beyond the project life so that there is an effect on the base case experienced for a medium or long term duration.
Low	An impact that may affect a small number of people and / or groups usually at the local area, and / or which would usually not extend beyond the life of the project so that base case is not affected beyond a short or medium term duration.
Negligible	An impact that would be temporary and short or medium term in duration and / or which is unlikely to appreciably affect the well-being of people, or the function and / or quality of a resource that they use, either beneficially or adversely, or cause an appreciable economic / financial gain or loss.

10.5.35 The logic employed and the rationale for the assessment of impact magnitude has been presented in full within each assessment.

10.5.36 In the case of public open spaces, child play spaces, and community facilities, the catchment area of the facility has been identified within the baseline having regard to published standards, where existing, identified in Vol 2 Table 10.5.1, and this has been taken into account in evaluating the magnitude of the impact.

Determining significance of effects

10.5.37 The significance of socio-economic effects have been determined by combining the identified impact magnitudes with the receptors affected by those impacts (taking account of their sensitivity), as set out in Vol 2 Table 10.5.3 below.

10.5.38 The significance matrix employed for assessing socio-economic effects is the same as the generic significance matrix presented in Section 3 of this volume with one exception. Where a receptor that has been assessed to be highly sensitive is subject to an impact that has been assessed to be negligible, the significance matrix has been altered to allow for the assessment to arrive at a conclusion that the effect on the receptor is either minor adverse or negligible (as opposed to solely minor adverse) overall. This alteration has been made to allow for those circumstances where, despite being a high sensitivity receptor, the nature of the impact means that the overall effect has been judged to be non-existent or ‘negligible’. The logic employed in reaching this judgement in such case has been presented within the assessment.

10.5.39 For socio-economics, major and moderate effects (both adverse and beneficial) are considered to be significant while minor and negligible effects are considered to be not significant.

10.5.40 The approach to determining the significance of socio-economic effects is presented in Vol 2 Table 10.5.3 below.

Vol 2 Table 10.5.3 Socio-economics – significance matrix

Significance		Sensitivity of receptor		
		High	**Medium**	**Low**
Impact magnitude	High	Major adverse / beneficial	Major adverse / beneficial	Moderate adverse / beneficial
	Medium	Major adverse / beneficial	Moderate adverse / beneficial	Minor adverse / beneficial
	Low	Moderate adverse / beneficial	Minor adverse / beneficial	Negligible effect
	Negligible	Minor adverse / beneficial or Negligible	Negligible effect	Negligible effect

Note: the red shaded area represents 'significant effects', and the green shaded area represents 'not significant effects'.

10.6 Operational effects assessment

10.6.1 Given the nature of the project in the operational phase, the operational effects assessment for socio-economics is more limited in scope than the construction effect assessment. This is because the operation of the Thames Tideway Tunnel project would give rise to different effects on socio-economic receptors compared to the construction phase. For example, the temporary diversion of public rights of way and take up of open space arising due to the physical extent of construction work sites only take place during construction. Similarly, there would be no large scale construction employment, nor would there be amenity effects on socio-economic receptors of the sort arising as a result of construction activity. Therefore, the operational effects assessment has been limited to assessing the following types of effects:

a. Permanent change or reduction in the supply of employment land.

b. Permanent gain of public amenity space and / or permanent enhancement or provision of a public right of way.

10.6.2 Where an effect is initially caused during the construction phase, but may last through into the operational phase, the effect has been assessed solely under the construction effects assessment and the longer term or permanent nature of the effect has been taken account of.

10.6.3 The operational effects assessment has been conducted on a similar basis to the construction effects assessment except for those points clarified below.

10.6.4 Consideration is given to the extent to which the operational assessment findings would be likely to vary materially from those assessed, should the programme for the Thames Tideway Tunnel project be delayed by approximately one year. At the majority of sites the base case would be considered to remain the same should there be a delay of one year. Exceptions to this are at sites where cumulative developments would have been completed during this timeframe. The sites at which this assessment has been applied are:

a. Cremorne Wharf Depot

b. Greenwich Pumping Station

c. Hammersmith Pumping Station

d. Heathwall Pumping Station, and

e. Kirtling Street

10.6.5 For some of the sites, the types of effects listed under para. 10.6.1 do not apply, and therefore operational effects are not relevant and are not considered further. Where this has been the case the rationale for this has been set out within the relevant site-specific volumes.

Assessment year

10.6.6 The operational assessment year for the purposes of the socio-economic assessment is Year 1 of operation.

Assessment areas

10.6.7 The assessment area, including the impact study area and geographical area of effect are the same as for the construction effect assessment (see Vol 2 Table 10.5.1).

Methodology

10.6.8 Operational effects have been assessed in the same way as construction effects.

Significance criteria

10.6.9 The significance criteria, including the determination of the magnitude of impact, have been applied on the same basis as for the construction effect assessment.

10.7 Cumulative effects assessment

10.7.1 The general approach to assessing cumulative effects is described in Section 3 General EIA methodology. The specific approach for socio-economics is described below. The assessment years considered for the cumulative effects assessment remain as defined in Sections 10.5 and 10.6 above.

10.7.2 There may be potential for cumulative effects to arise in the event that other developments are under construction at the same time as the project, and if the impacts of these developments combine with the impact of the proposed Thames Tideway Tunnel project. This assessment has been documented within the respective site specific and project-wide assessments for which cumulative effects are relevant.

Construction

10.7.3 Based on the available planning information for the locality of each site (including the other side of the River Thames where appropriate), other developments have been assessed to ascertain whether or not a cumulative effect in relation to socio-economics would be likely to occur.

10.7.4 The assessment has been conducted on a qualitative basis using professional judgement but with reference to numerical and statistical inputs where available and using the same assessment criteria used in the construction effects assessment.

10.7.5 Cumulative effect assessments at a site specific level have been conducted in respect of economic effects (including effects on businesses), effects on social infrastructure and effects on amenity. In relation to the cumulative effects assessment that has been conducted in respect of amenity effects on potentially sensitive socio-economic receptors during construction, this has been conducted having regard to other cumulative construction projects located up to 250m from the LLAU. This assessment has been undertaken by reviewing the amenity related effect topics' cumulative assessment findings. Where one or more of the other topics have concluded that there would be significant cumulative effects, a qualitative assessment employing professional judgement has been made of whether or not this would give rise to an elevated and overall significant cumulative amenity effect.

10.7.6 For assessments of cumulative socio-economic effects presented in the *Environmental Statement*, the significance criteria applied are the same as those set out in Vol 2 Table 10.5.3.

Operation

10.7.7 As described in para. 10.6.1, the operational effects assessment has identified two effects for assessment in the operational phase, namely effects on the provision of employment land and effects arising from the provision of additional public open space / public realm.

10.7.8 For socio-economics, where any other development would give rise to an effect on the provision of employment land or an effect on the provision of additional public open space / public realm, the effect is considered to alter the base case rather than lead to a cumulative effect. For this reason, no developments were identified as capable of giving rise to cumulative effects on socio-economics receptors. Therefore, there would be no cumulative socio-economic effects in the operational phase.

10.8 Project-wide effects assessment

10.8.1 The general approach to assessing the likely significant effects, including project-wide effects, is described in Section 3. The specific approach for assessing project-wide socio-economics effects is described below.

Assessment years

Construction

10.8.2 The construction assessment year is the peak year of construction activity.

10.8.3 However, because the project may have a continuing impact, in both social and economic terms, from the start to the finish of construction, regard has been had to the total duration of the construction period within the project-wide assessment.

Operation

10.8.4 The operational assessment year is Year 1 of operation, which is the first full year of operation.

Assessment areas

10.8.5 For the project-wide assessment, effects have been assessed at a Greater London level or at the level of the wider River Thames and Thames Estuary:

a. The principal economic effects of the project (including employment generation and economic stimulus to key industries) have been considered relative to Greater London, as this represents the principal labour market catchment area. The principal labour market is commonly known as the Travel to Work Area (TTWA) and has been derived by analysing 2001 Census data. The locations where construction would take place are accessible from all areas of Greater London, and are served by labour from all boroughs across Greater London. The labour market catchment area represents the typical spatial extent of the majority of indirect and induced economic activity. It also incorporates the population that may reasonably be expected to travel to and benefit from employment opportunities arising from the proposed development. Similarly, the movement of material by barge along the River Thames operates across Greater London and Thames Estuary area.

b. With regard to leisure, recreation and tourism receptors, the assessment area reflects that section of the River Thames and its environs which serve a leisure, recreation and / or tourism function and which, in some way, would be affected by either the construction or operation of the Thames Tideway Tunnel project.

10.8.6 The various spatial levels of analysis and associated rationale are set out in detail below in Vol 2 Table 10.8.1.

Vol 2 Table 10.8.1 Socio-economics – project-wide assessment areas

Impact	Assessment area – impact study area / geographical area of effect	Rationale
Net employment generation	Greater London	Travel to Work Area, derived from Census 2001
Impact on wider London economy and economic sectors	Greater London	Travel to Work Area, derived from Census 2001;
Project-wide impact on open space and public right of way (ie, Thames Path) users within Greater London	Greater London	GLA, *London Plan 2011* / Professional judgement of the spatial incidence of River Thames related recreational activities at a metropolitan level
Project-wide impact on recreational river space users within Greater London	Greater London and Thames Estuary	Professional judgement of the spatial incidence of River Thames related recreational waterborne activities at the metropolitan level
Project-wide impacts on recreation, leisure and tourism within Greater London	Greater London	Travel to Work Area, derived from Census 2001 / Professional judgement of the spatial incidence of River Thames related recreational activities at a metropolitan level
Project-wide aesthetic, public health and amenity effects of improved water quality and regulatory compliance	Greater London and Thames Estuary	Spatial incidence of development scheme

Methodology

10.8.7 The project-wide assessment has sought to establish the net potential economic and social effects of the project in respect of:

a. Employment

b. Recreation and leisure and tourism

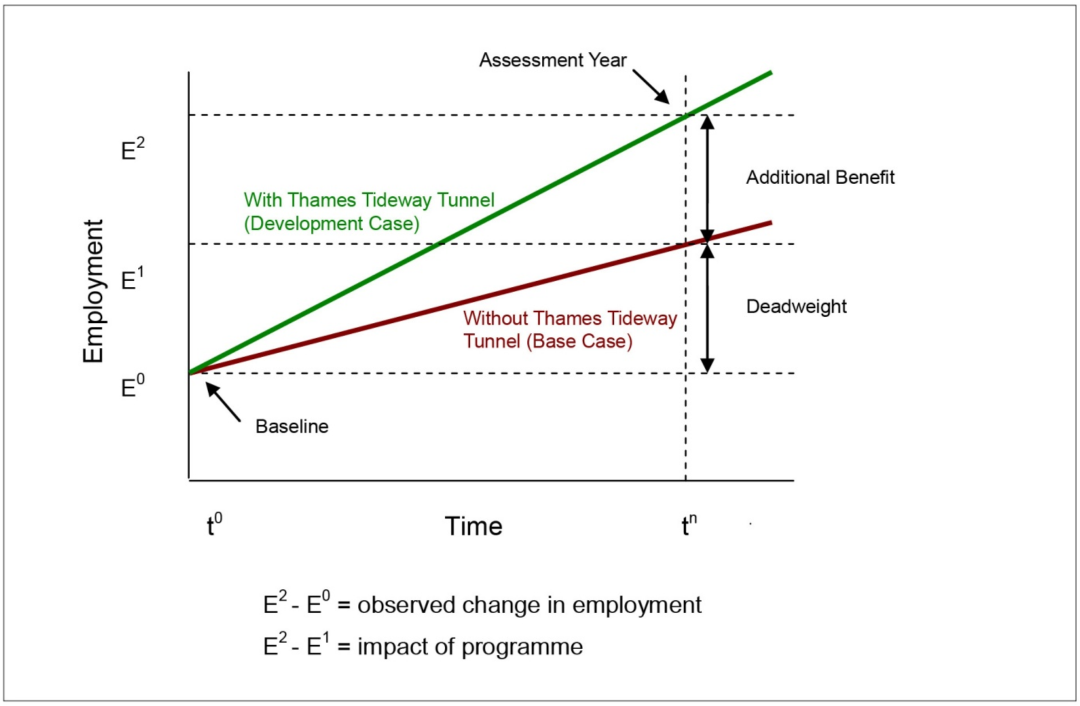
c. Public health

Economic effects, including employment generation

10.8.8 The basic assessment model employed to assess employment and economic effects is shown graphically in Vol 2 Plate 10.8.1 (Scottish Enterprise , 2008). The graph illustrates how the additional benefit of the project has been identified, ie, the additionality of the project. Additionality can be defined as the additional impact that arises as a result of an intervention (ie, a project – in this case the Thames Tideway Tunnel) that would not have occurred in the absence of that intervention.

10.8.9 This is achieved by establishing what would have happened in the absence of the project (ie, in the base case, or 'Without Thames Tideway Tunnel' as shown in the plate). This has then been subtracted from the predicted effect of the project (ie, what would happen 'With Thames Tideway Tunnel' as shown in the plate) after allowing for a series of adjustments factors to reflect leakage, displacement, deadweight, and the multiplier effect (see para. 10.8.12 for further detail as to the meaning of these terms). This allows the full effect of the proposed development to be presented accurately.

Vol 2 Plate 10.8.1 Socio-economics – assessing additionality



Source: Adapted from Figure 3.1, Additionality and Economic Impact Assessment Guidance Note, Scottish Enterprise, 2008

10.8.10 The base case is what would happen without the proposed development in the future. The base case would change over time. For example, the workforce in given sectors such as the construction sector, is likely to change over time as a result of natural population growth and economic circumstances. Also, new businesses could open or expand and equally businesses could fail for a wide range of factors.

10.8.11 The development case is the future case scenario where the proposed development is delivered. The development case has been compared against the base case for the relevant assessment year to give the net impacts and effects.

10.8.12 The assessment of employment generation has been based on estimates of direct peak employment generation produced by the Thames Tideway Tunnel project associated with the proposed construction methods and transport logistics strategy. The estimates of indirect employment generation have been arrived at by employing a formula that takes account of certain adjustment factors referred to as leakage, displacement, deadweight, and the multiplier effect. These factors are explained following:

a. Leakage effects are the benefits to those outside the impact area.

b. Displacement measures the extent to which the benefits of a project are offset by reductions of output or employment elsewhere.

c. Deadweight represents the effects that would occur if the project did not go ahead.

d. Multiplier effects represent the fact that in addition to the direct construction employment generated by the project itself there would be an increase in local employment arising from the indirect effects of the Thames Tideway Tunnel project construction activity. Two multipliers are applicable to this assessment:

    i Multiplier effects applicable to the main construction activity.

    ii Multiplier effects applicable to other direct employment and deadweight.

10.8.13 The assumptions made in respect of these adjustment factors specific to the project-wide assessment are set out in detail within the project-wide assessment.

10.8.14 Where relevant, the project wide effect assessment has had regard to the outcomes of the *Skills and Employment Strategy* (which accompanies this application) in order to inform the assessment of effects on workers and workers' skills levels.

Effects on recreation, leisure and tourism

10.8.15 The assessment of recreation, leisure and tourism effects has been conducted in the same way as the assessment of construction and operational effects on public open space and public right of way users at site specific level, but having regard to the project-wide spatial dimensions of the proposed development in terms of examining the net impact on recreation, leisure and tourism at the Greater London and Thames Estuary level.

10.8.16 Where relevant, the project wide effect assessment has had regard to other topics and studies including the Surface water assessment (see Vol 3 Section 14) and the outcomes of the *Health Impact Assessment (HIA)* (which accompanies this application) in order to inform the assessment of effects on recreation, leisure and tourism.

Significance criteria

Determining magnitude of impacts

10.8.17 For assessments of project-wide socio-economic effects, the impact magnitude criteria applied are the same as those set out in Vol 2 Table 10.5.2.

Determining significance of effects

10.8.18 For assessments of project-wide socio-economic effects, the significance criteria applied are the same as those set out in Vol 2 Table 10.5.3.

Project-wide cumulative effects

Construction

10.8.19 The project-wide assessment of cumulative construction effects has had regard to the potential for cumulative effects arising from the Thames Tideway Tunnel project and other major projects of significance at the Greater London level in respect of the effects considered within the project-wide assessment.

10.8.20 The assessment has been conducted on a qualitative basis using professional judgement but with reference to numerical and statistical inputs where available.

10.8.21 For assessments of project-wide socio-economic effects, the significance criteria applied are the same as those set out in Vol 2 Table 10.5.3.

Operation

10.8.22 The project-wide assessment of cumulative operational effects has had regard to the potential for cumulative effects arising from the Thames Tideway Tunnel project and other major projects of significance at the Greater London level in respect of the effects considered within the project-wide assessment.

10.8.23 The assessment of cumulative effects in regard to project-wide operational employment has been conducted on a qualitative basis using professional judgement but with reference to numerical inputs where available.

10.8.24 As discussed in para. 10.7.7, where any other development would give rise to an effect on the provision of additional public open space / public realm, the effect is considered to alter the base case rather than lead to a cumulative effect. For this reason, no developments were identified as capable of giving rise to cumulative effects on leisure, recreation or tourism receptors or on public health.

10.8.25 For assessments of project-wide socio-economic effects, the significance criteria applied are the same as those set out in Vol 2 Table 10.5.3.

10.9 Assumptions and limitations

10.9.1 This section details general assumptions and limitations associated with the socio-economics assessment. Site specific assumptions and limitations are detailed in Vol 4-27 Socio-economics.

Assumptions

10.9.2 For the purposes of the socio-economic impact assessment the following general assumptions have applied:

a. In many cases it has not been possible to obtain an accurate figure on the number of employees within the businesses that have been identified as receptors. The number of employees may vary in the period leading up to the base case due to changing economic and financial circumstances affecting those businesses. As such, ranges have been estimated with businesses classified as a micro, small, medium or large based on the number of workers known or estimated to be employed on site.

b. Where required, the estimated floorspace of the business has been used as the basis for estimating employee numbers.

10.9.3 A *compensation programme* has been established by Thames Water[xiii] (see para. 10.10.4 below). The *compensation programme* seeks to offset significant adverse construction phase effects where a receptor is identified to be eligible for compensation. Further information in relation to this *compensation programme* is contained in Schedule 2 of the *Statement of Reasons* which accompanies the application. For the purposes of the socio-economic impact assessment the following general assumptions have applied:

a. At sites where a business or organisation is located within the LLAU of the proposed development and the business would need to relocate to another site or reconfigure its operations, it has been assumed that reasonable costs and expenditure incurred in association with relocation would be met.

b. For commercial and community organisation receptors which would be likely to incur a financial loss as a result of the project and which are also entitled to submit a claim for financial loss, the compensation programme measures are considered to be mitigation. In such cases, the residual effect assessment reported in this ES would take the effect of these measures into account.

c. At sites where a moderate or major adverse effect on a residential receptor would arise due to amenity effects during construction; although compensation would be available where a receptor is identified to be eligible, the programme measures are not considered to be mitigation. This is because there is no guarantee that they would be accepted by the affected party. In such cases, the residual effects reported in this ES do not take the offsetting effects of these measures into account.

[xiii] 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.

Limitations

10.9.4 Socio-economic and demographic data presented relating to the local community profile and the local economy has been collected from data sources that are based on surveys undertaken at a fixed point in time, eg Census data collected in 2001 or indices of deprivation data from 2010. Some data provided on the use of facilities, local employment land vacancy rates, etc, is also historical rather than current and the date of the data has been given in each case. As such, data presented within the assessment is historic and accurate forecasts are either not available or cannot be accurately predicted.

10.9.5 However, the assessments of socio-economic effects have not been exclusively dependent on any single piece or set of data. The data provide context or guidance to the assessment and have not been directly relied upon in reaching an assessment of the significance of effects on individual receptors. Efforts have been made to obtain the most recently available data, including by undertaking primary data collection.

10.9.6 Notwithstanding these limitations, the methodology is robust, utilising reasonably available information, having reference to guidance and planning policy where applicable, and employing professional judgement. Therefore, the findings of the socio-economic assessment not been compromised and the findings presented herein are valid and robust.

10.10 Mitigation

Construction

10.10.1 The Thames Tideway Tunnel project has been designed to minimise environmental effects and the construction design / methods take account of socio-economics considerations by:

a. Facilitating the relocation of businesses or organisations with operations located within LLAU, and which must relocate in order to enable the project to proceed.

b. Presenting measures within the *Code of Construction Practice (CoCP)* within air quality, construction dust, noise, vibration (human response) and visual impact assessments to limit adverse effects on the amenity of residential, commercial, community and recreational receptors. The *CoCP* is provided in Vol 1 Appendix A. It contains general requirements (Part A), and site specific requirements for this site (Part B).

c. Proposing measures to reprovide social infrastructure, facilities or equipment elsewhere during the construction works where possible, and reinstate and in some cases improve open space / recreational infrastructure or facilities at the end of construction to enhance public open space, public recreation, and community facility users.

10.10.2 Where such measures form part of the project, they are identified in Volume 1 Introduction to the Environmental Statement (for the tunnel itself) and Section 3 of Vol 4-27 (for each site) and have been considered as embedded measures within the assessment.

10.10.3 Where the assessment of effects on amenity has indicated significant effects having taken account of embedded measures, mitigation has been identified as appropriate within the respective amenity related topic assessments. Mitigation is not always possible in every circumstance, and where this has been the case, it has been noted and explained in the relevant site specific assessment (see Section 4 Air quality and odour, Section 9 Noise and vibration, and Section 11 Townscape and visual of Vol 4-27).

10.10.4 The project has established a *compensation programme* (included within Schedule 2 of the *Statement of Reasons*, which accompanies the application), which goes beyond legal requirements. The programme has been established to address claims of exceptional hardship or disturbance where a receptor is identified to be eligible for compensation. The compensation programme includes a provision relating to disturbance during construction of the Thames Tideway Tunnel project giving rise to financial loss or damage to property. The policy addresses particularly sensitive areas where claims may fall outside the current legal compensation regime and may relate to construction disturbance such as: noise, dust, vibration, light disturbance from worksites at night, or damage to property as a result of construction. Any claim which is accepted would be made subject to specific conditions and would likely include mitigation works or other required actions to reasonably reduce the ongoing disturbance. Details of the compensation programme are contained in the Thames Tideway Tunnel compensation programme (see Schedule 2 of the *Statement of Reasons*, which accompanies this application).

Operation

10.10.5 The nature of the project during operation means any effects are either negligible or beneficial in nature. Accordingly, the socio-economic impact assessment has not identified any major or moderate adverse effects requiring mitigation and there are no socio-economic considerations which require mitigation.

10.11 Residual effects assessment

10.11.1 Where mitigation measures are proposed, residual effects are assessed by reconsidering the degree to which the proposed mitigation results in a change in the factors that determine the magnitude of impact. This exercise has been undertaken in the same way as the original assessment, having regard to information about the project and employing professional judgement. If the magnitude of impact is considered to have reduced, then it is likely that the overall effect assessment would also reduce, subject to the significance matrix and the sensitivity of the receptor.

10.11.2 Where no mitigation measures are proposed, the residual effects remain as identified through the relevant assessment (construction, operation or project-wide).

References

[1] Department of Environment, Food and Rural Affairs (DEFRA). *National Policy Statement for Waste Water: A framework document for planning decisions on nationally significant waste water infrastructure* (2012).

[2] Greater London Authority (GLA). *The London Plan – Spatial Development Strategy for Greater London* (2011).

[3] Office of the Deputy Prime Minister. *Creating, Using and Updating a Neighbourhood Baseline* (2004).

[4] Office of the Deputy Prime Minister. *Employment Land Reviews: Guidance Note* (2004).

[5] Homes and Communities Agency. *Employment Densities Guide*, 2nd Edition (2010).

[6] English Partnerships Additionality Guide. *A Standard Approach to Assessing the Additional Effect of Projects,* 3rd Edition (2008).

[7] Scottish Enterprise. *Additionality & Economic Impact Assessment Guidance Note: A Summary Guide to Assessing the Additional Benefit, or Additionality, of an Economic Development Project or Programme* (2008). Available at: http://www.scottish-enterprise.com/~/media/SE/Resources/Documents /ABC/additionality-and-economic-impact-assessment-guidance.ashx.

[8] Office for National Statistics (ONS). *Annual Population Survey* (2012). Available at: https://www.nomisweb.co.uk/reports/lmp/la/contents.aspx.

[9] ONS. *Neighbourhood Statistics* (2001). Available at: http://neighbourhood.statistics.gov.uk/dissemination/.

[10] ONS. *Construction Statistics – Annual Report 11* (2010). Available at: http://data.gov.uk/dataset/construction_statistics.

[11] Department for Communities and Local Government. *Index of Multiple Deprivation 2010* (2010). Available at: http://www.communities.gov.uk/communities/research/indicesdeprivation/deprivation10/.

[12] Department for Education. *Edubase* (Register of educational establishments). Available at: http://www.education.gov.uk/edubase/home.xhtml.

[13] Experian. *National Business Database* (Database of employment and enterprise statistics). Accessed: September 2012.

[14] Glenny. *Glenny Databook: Quarter 1 2007* (2007). Available at: http://www.glenny.co.uk/default.aspx?mId=52

[15] Glenny. *Glenny Databook: Essential Market Data Quarter 3 2011* (2011). Available at: http://www.glenny.co.uk/default.aspx?mId=52.

[16] Keep Britain Tidy. *Awarding well-managed parks & green spaces.* Available at: http://greenflag.keepbritaintidy.org/awards/.

[17] GLA. *London's Economy Today* (February 2012 edition).

[18] Greater London Authority. *Green infrastructure and open environments: The All London Green Grid Supplementary Planning Guidance*. (2012).

[19] London Development Agency / Greater London Authority. *London's Industrial Land Baseline* (2010).

[20] London Parks and Gardens Trust. *London Gardens Online.* Available at: http://www.londongardensonline.org.uk/.

[21] GLA. *The London Plan – Spatial Development Strategy for Greater London* (2011).

[22] London Public Health Observatory. *Fair Society, Healthy Lives: The Marmot Review (2012)*. Available from: http://www.lho.org.uk/LHO_TOPICS/NATIONAL_LEAD_AREAS/MARMOT/MARMOTINDICATORS.ASPX. Accessed 30 August 2012.

[23] LB of Ealing. *Ealing Green Space Strategy 2012-2022* (2011).

[24] LB of Hammersmith and Fulham. *Background Paper: Employment Land Assessment – Updating Statement* (2009).

[25] LB of Hammersmith and Fulham. *Environment and Planning website (Parks and open spaces: Frank Banfield Park).* Available at http://www.lbhf.gov.uk/Directory/Environment_and_Planning/Parks_and_open_spaces/Find_a_park/115027_Frank_Banfield_Park.asp. Accessed 22 June 2012.

[26] LB of Hounslow. *London Borough of Hounslow Employment Land Review* (2011).

[27] LB of Lewisham. *Conservation Sites – Sue Godfrey Nature Park.* Available at: http://www.lewisham.gov.uk/Environment/CleanerGreenerLewisham/NatureConservation/ConservationSites/SueGodfreyNaturePark.htm.

[28] LB of Lewisham. *Lewisham Core Strategy Development Plan Document* (2011).

[29] LB of Lewisham. *LB Lewisham Employment Land Study* (2008).

[30] LB of Lewisham. *Lewisham Leisure and Open Space Study* (2010).

[31] LB of Richmond upon Thames. *Core Strategy* (2009).

[32] LB of Richmond upon Thames (2007). *Sport, open space and recreation needs assessment*. Available at: http://www.richmond.gov.uk/home/environment/planning/planning_guidance_and_policies/local_development_framework/local_development_framework_research/sport__open_space_and_recreation_needs_assessment.htm.

[33] LB of Southwark. *LB Southwark Open Space Study* (2010).

[34] LB of Tower Hamlets. *Open Space Strategy* (2005).

[35] LB of Tower Hamlets. *KEMP Management Plan 2007-17* (2008).

[36] LB of Wandsworth website, Barn Elms Boathouse information page. Available at: http://www.wandsworth.gov.uk/info/644/sports_facilities/383/barn_elms_boathouse. Accessed February 2012.

[37] LB of Wandsworth. *Wandsworth Core Strategy Development Plan and Policies Document* (2010).

[38] LB of Wandsworth. *Wandsworth Employment Land and Premises Study* (2010).

[39] LB of Wandsworth. *Wandsworth Open Space Study* (2007).

[40] NHS Choices. *GP Surgeries* (2012). Available at: http://www.nhs.uk/servicedirectories/Pages/ServiceSearch.aspx?ServiceType=GP.

[41] Network of Public Health Observatories. *Health Profiles: London* (2011-2012). Available at: http://www.apho.org.uk/resource/view.aspx?QN=HP_REGION_H. Accessed February 2012.

[42] ONS. *Commercial and Industrial Property Vacancy Statistics* (2005).

[43] ONS. Labour Market Statistics June 2012 (2012).

[44] RB of Kensington and Chelsea. *Core Strategy for the Royal Borough of Kensington and Chelsea* (2010).

[45] RB of Kensington and Chelsea. *Cremorne Gardens Management Plan* (2012)

[46] RB of Kensington and Chelsea. *Westfield Park Ten-year Management Plan* (2012).

[47] Lane, et al. *The Thames Recreational Users Study (Produced by a collaborative partnership project between the City of London Port Health Authority and Health Protection Agency)* (2007).

---

[48] Thames Tideway Tunnel. *River Usage Survey. Boat and pedestrian activity in the proximity of specific* worksites (2012).

[49] Transport for London. *London River Services* (2012). Available at: http://www.tfl.gov.uk/corporate/modesoftransport/1562.aspx#piers.

[50] Visit Britain. *Inbound Visitor Statistics* (2012).

[51] VisitBritain. *Foresight Issue 100* (2012).

[52] Department for Business Innovation and Skills. *Small and Medium Enterprise Barometer* (2011). Available at: http://www.bis.gov.uk/assets/biscore/enterprise/docs/s/11-p75c-sme-business-barometer-august-2011.pdf. Accessed 22 June 2012.

[53] Environment Agency (EA). *Additional guidance for H4 Odour Management: How to comply with your environmental permit* (2011). Available at: http://publications.environment-agency.gov.uk/PDF/GEHO0411BTQM-E-E.pdf. Accessed: July 2012.

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.02**

Volume 2: Environmental assessment methodology

Section 11: Townscape and visual

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

Hard copy available in

Box **16** Folder **A**
January 2013

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

This page is intentionally blank

Thames Tideway Tunnel

Environmental Statement

Volume 2: Environmental assessment methodology

Section 11: Townscape and visual

List of contents

Page number

List of plates

Page number

List of tables

Page number

11 Townscape and visual

11.1 Introduction

11.1.1 This section sets out the methodology for assessing the likely significant effects of the Thames Tideway Tunnel project on townscape and visual receptors. The methodology outlined in this section has been applied to all sites, unless otherwise indicated.

11.1.2 The need for an assessment of townscape and visual effects results from the potential for the project to give rise to significant effects on townscape and visual receptors during both construction and operation. The findings of the assessment have been iteratively fed back into the design process to reduce adverse effects and promote beneficial effects wherever possible. This is described in more detail in para. 11.5.2 for construction and para. 11.6.2 for operation.

11.1.3 The topic specific methodology presented in this section builds upon the general assessment methodology summarised in Section 3 of this volume and develops this to take account of the range of likely significant environmental effects on townscape and visual receptors. The remainder of this introduction describes the components of the townscape and visual assessment to provide the context for the methodology that follows.

11.1.4 The townscape assessment has been undertaken for the peak construction year (defined in para. 11.5.3) and for relevant sites, Year 1 and Year 15 of operation. The purpose of the Year 15 of operation assessment is to assess the effect that vegetation established as part of the proposed development would have on townscape character once it has matured.

11.1.5 For the assessment of visual effects, for all sites an assessment of construction effects has been undertaken during winter when the screening effect of vegetation is limited and construction activity would be most visible. An assessment of construction effects has not been undertaken during summer as vegetation is in leaf and more likely to provide screening of construction effects. Where 24 hour lighting is proposed during construction for durations in excess of four months, an assessment of visual effects during winter at night has also been undertaken.

11.1.6 A Year 1 of operation visual assessment for relevant sites has been undertaken during winter and summer. The purpose of the summer assessment is to examine how the effects of the proposed development is altered by surrounding vegetation in leaf, therefore providing a year round assessment of the permanent development.

11.1.7 A Year 15 of operation visual assessment for relevant sites has been undertaken during summer only. This is to assess the screening effect that vegetation established as part of the proposed development would have once it has matured.

11.1.8 During operation, it is not envisaged that there would be any significant effects arising from lighting. Therefore, no assessment has been undertaken with the exception of sites where this has been requested by stakeholders. Where applicable, designs have followed local lighting standards to minimise adverse effects.

11.1.9 Effects arising from the intervisibility of multiple Thames Tideway Tunnel project sites are assessed in each site volume. Effects at a project-wide scale are not considered likely because all effects would arise from individual Thames Tideway Tunnel project sites and there are no receptors which exist at a project-wide scale. Therefore, project-wide effects have not been assessed.

11.2 Engagement

11.2.1 The general approach adopted regarding engagement is summarised in Section 2 of this volume.

11.2.2 Topic position papers, outlining the proposed townscape and visual assessment methodology, were circulated to English Heritage and all local authorities within the assessment area prior to the *Scoping Report*. Comments received on these papers were addressed and incorporated into the *Scoping Report* before distributing for a formal scoping opinion.

11.2.3 The *Scoping Report* (March 2011) set out the proposed approach to the assessment of townscape and visual effects for each site. Site-specific comments received in response to this from stakeholders are presented within each site assessment volume (see Section 11.2 of Vol 4 to 27). Overarching methodological comments have been provided by English Heritage and the Infrastructure Planning Commission. These are summarised in Vol 2 Appendix A.3 and I.1 along with a description of how these comments have been addressed.

11.2.4 Following the scoping process, there has been ongoing engagement on the detailed approach to the townscape and visual assessment. English Heritage and all the local authorities along the route of the proposed tunnel have been consulted on the proposed viewpoints for the visual assessment. Comments were received on the scope of the assessment area and the number and location of visual assessment viewpoints. Comments were also received on the number and location of accurately prepared digital visualisations of the proposed development, termed verifiable photomontages. These comments have been taken into account in the assessment. Further detail is set out in each site volume (see Section 11.2 of Vol 4 to 27).

11.2.5 Throughout the assessment process, there has been ongoing engagement with stakeholders on the development of the design and mitigation measures; these have been incorporated into the proposals, as detailed in each site volume (see Section 11.2 of Vol 4 to 27). This process has included a number of site visits in March 2011 with English Heritage and the Environment Agency (EA).

11.2.6 Feedback on the preliminary townscape and visual assessment has been provided by stakeholders as part of phase two and Section 48 consultation. All feedback relating to individual Thames Tideway Tunnel project sites is included in the site volumes. One stakeholder, English Heritage, provided general comments on the townscape and visual methodology, which is summarised in Vol 2 Appendix I.1.

11.3 Legislation and guidance

11.3.1 The methodology for the townscape and visual assessment follows the guidelines set out in the following documents:

a. *Guidelines for Landscape and Visual Impact Assessment* (*GLVIA*) (Landscape Institute and the Institute for Environmental Management and Assessment, 2nd Edition, 2002)[1].

b. *Consultation draft of the Guidelines for Landscape and Visual Impact Assessment (GLVIA)* Landscape Institute (3rd Edition, 2011).

c. *Design Manual for Roads and Bridges* (DMRB), Volume 11 Section 3 Part 5 'Landscape Effects' (Department for Transport, 1993)[2].

d. *The London Mayor's London View Management Framework* (*LVMF*, 2012)[3].

e. *National Policy Statement for Waste Water (NPS)* (Water Department of food and rural affairs, February 2012)[4]

f. *National Planning Policy Framework* (NPPF) (Department for Communities and Local Government, March 2012)[5]

11.3.2 As there is no legislation specific to the assessment of townscape and visual effects, the methodology follows the guidance provided in the *GLVIA* 2nd Edition, taking into account recent developments outlined in the 3rd Edition (for example, through avoiding judgements on landscape quality). Guidance from the DMRB has been used specifically in identifying representative viewpoints from visual receptors. Whilst this document is under review it remains an accepted standard for townscape and visual assessment.

11.3.3 The *LVMF* designates protected viewing corridors and viewpoints across London to protect them from inappropriate development. Within the townscape and visual assessment area for the Thames Tideway Tunnel project, there are the following three types of protected views:

a. Linear Views from Westminster Pier and Richmond Park to St Paul's Cathedral.

b. London Panoramas from Greenwich Park and Blackheath Point to St Paul's Cathedral.

c. River Prospects from bridges and vantage points along the River Thames.

11.3.4 For all sites located within the horizontal and vertical plane of a Linear View or London Panorama, an assessment of visual effects has been undertaken in line with the methodology described in the *LVMF*. It should be noted that the *London Plan 2011 LVMF* policies relate to permanent development. However, the effect on these protected viewing corridors has also been assessed during construction as they are located within the construction phase ZTV of some sites. This therefore forms a robust approach.

11.3.5 An assessment of visual effects on all River Prospects located within the ZTV of any site has again been undertaken in line with the methodology described in the *LVMF* for both the construction and operational phases.

11.3.6 The *National Policy Statement (NPS) for Waste Water* recognises that in built up areas there are likely to be adverse townscape and visual effects (para. 1.4.4 of the *NPS*). The table below presents the requirements within the NPS relevant to townscape and visual resources and explains how the requirements have been addressed within the ES. The table below also gives the location of the relevant material.

Vol 2 Table 11.3.1 Townscape and visual – requirements of the NPS and how they have been addressed

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
The applicant should carry out a landscape and visual assessment and report it in the *Environmental Statement*. A number of guides have been produced to assist in addressing landscape issues (GLVIA).	A townscape and visual assessment has been prepared and reported in the *Environmental Statement*. The methodology, set out in this volume, has been derived from the GLVIA and DMRB guides, taking account of recent developments as described in para. 11.3.1.	Full details of the townscape and visual assessment methodology are set out in this volume.
The landscape and visual assessment should include reference to any landscape character assessment and associated studies, as a means of assessing landscape impacts relevant to the proposed project.	Within the townscape and visual assessment area, no landscape character assessments have been prepared by local authorities or stakeholders. A townscape character assessment has been prepared for the project with reference to relevant designations such as conservation areas and open spaces, in line with the methodology set out in this volume.	The methodology for preparing the townscape character assessment is set out in Section 11.4 of this volume.

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
The applicant's assessment should include the effects during construction of the project and the effects of the completed development and its operation on landscape components and landscape character.	The townscape assessment includes effects during both construction and operation for all sites which may give rise to significant effects. Impacts on townscape components within the site (defined by the limits of land to be acquired or used) are recorded and used as a basis for the assessment of the overall effect on townscape character.	Section 11.4 of this volume.
The assessment should include the visibility and conspicuousness of the project during construction and of the presence and operation of the project and potential impacts on views and visual amenity. This should include any light pollution effects including on local amenity and nature conservation.	The visual assessment includes effects during both construction and operation for all sites which may give rise to significant effects on visual receptors. Amenity effects, which may arise from a combination of visual, noise and air quality effects are considered in the socio-economics assessment (described in Section 10 of this volume). Where 24 hour lighting is proposed during construction for durations in excess of four months, an assessment of the effects of light pollution has been undertaken. An assessment has also been undertaken for sites during operation where requested by stakeholders. The effects of lighting on nature conservation are considered in the aquatic and terrestrial ecology assessments (described in Section 5 and Section 6 of this volume respectively).	Visual assessment methodology – Section 11 of this volume. Socio-economics assessment methodology – Section 10 of this volume. Aquatic ecology assessment methodology – Section 5 of this volume. Terrestrial ecology assessment methodology – Section 6 of this volume.
Landscape effects	Judgements on the	The process for

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
depend on the existing character of the local landscape, its current quality, how highly it is valued and its capacity to accommodate change. All of these factors need to be considered in judging the impact of a project on landscape.	sensitivity of townscape character areas have been made with reference to character, condition, tranquillity and value. The sensitivity to change has been considered alongside the magnitude of change to determine the significance of effect on townscape character areas.	assessing effects on the townscape is set out in Vol 2 Plate 11.5.1
Outside nationally designated areas, there are local landscapes that may be highly valued locally and protected by local designation. However, local landscape designations should not be used in themselves as reasons to refuse consent, as this may unduly restrict unacceptable development.	The townscape assessment takes account of relevant local designations in helping to determine the sensitivity of townscape character areas.	Refer to Vol 2 Table 11.4.1 for information on desk based baseline data sources.
Within a defined site, adverse landscape and visual effects may be minimised through appropriate siting of infrastructure within that site, design including colours and materials, and landscaping schemes, depending on the size and type of proposed project.	The Thames Tideway Tunnel project has been designed to minimise environmental effects and therefore the design takes account of townscape and visual considerations including a commitment to a high quality design for above ground structures, river walls and public realm. Where such measures form part of the project, they have been considered as embedded measures within the assessment.	Section 11.10 of this volume.

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
Depending on the topography of the surrounding terrain and areas of population it may be appropriate to undertake landscaping off site.	Where possible, off site planting has been proposed to reduce townscape and visual effects in agreement with stakeholders.	Refer to Section 11.2 of Volumes 4 (Acton Storm Tanks), 9 (King George's Park) and 11 (Falconbrook Pumping Station).

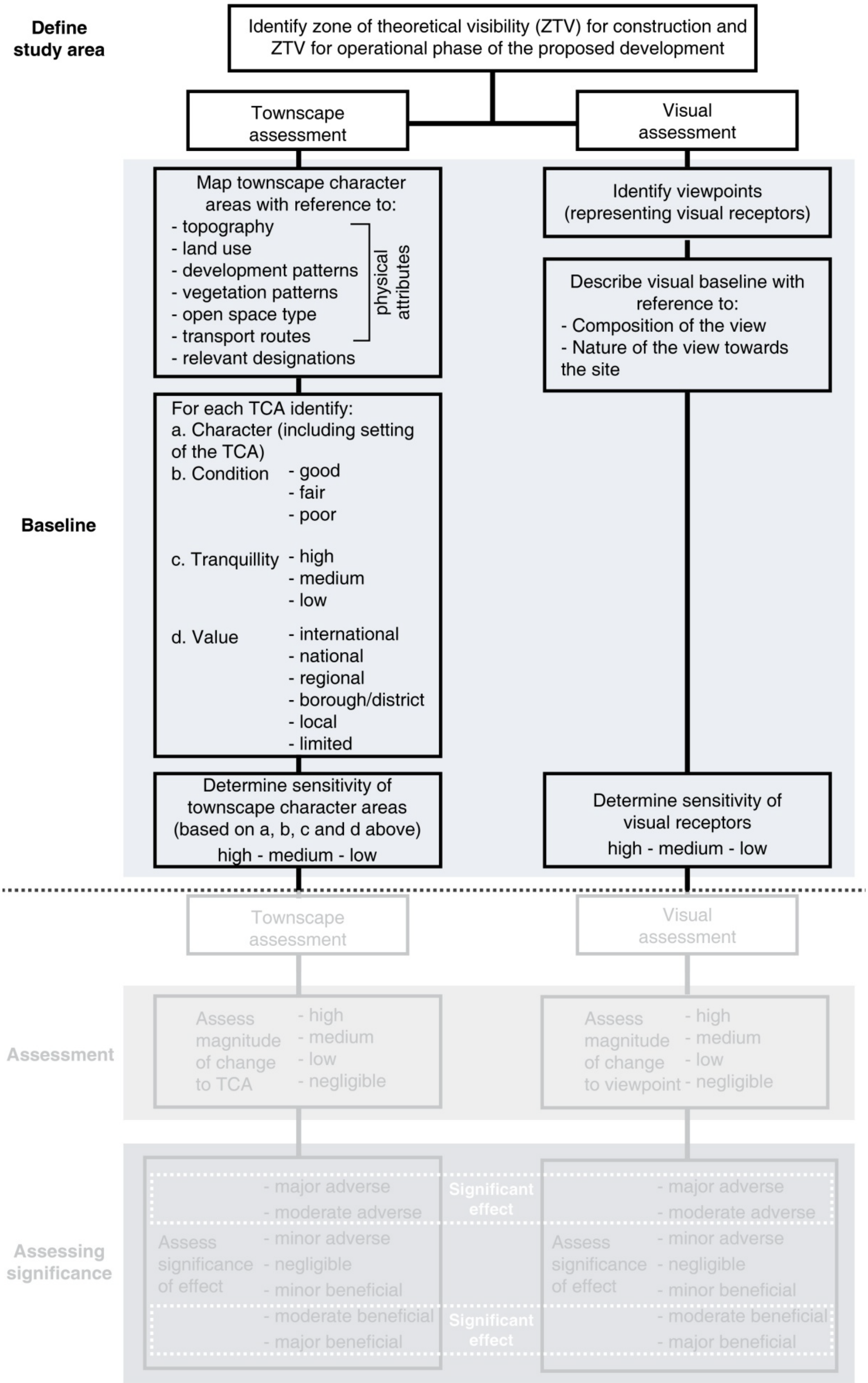
11.3.7 At a strategic level, the *National Planning Policy Framework (NPPF*) seeks to protect and enhance valued landscapes. This objective has underpinned the approach to the assessment which has sought to prevent and avoid adverse townscape and visual effects as far as practicable.

11.3.8 The methodology has been developed in close liaison with the historic environment methodology to ensure both assessments cover inter-linked issues appropriately, for example assessment of effects on conservation areas and historic parks and gardens. 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. This is explained in each site volume as required.

11.4 Baseline data collection

11.4.1 The townscape and visual baseline has been established through desk based research and field survey to establish the character of each site, surrounding areas and the nature of existing views. The desktop and field survey data sources are outlined below, followed by the approach to establishing the townscape and visual baseline which is summarised in Vol 2 Plate 11.4.1 below.

Vol 2 Plate 11.4.1 Townscape and visual – baseline process



Desk based baseline data

11.4.2 Desk based data sources used in the establishment of the townscape and visual baseline are described in Vol 2 Table 11.4.1 below.

Vol 2 Table 11.4.1 Townscape and visual – desk based baseline data sources

Source	Data	Notes
Greater London Authority	*The London Plan 2011* (GLA, 2011)[6]	Information on London-wide policies and designations (eg, green belt, Metropolitan Open Land and protected viewing corridors) to inform both the townscape and visual assessment.
Greater London Authority	*The London View Management Framework (LVMF) Supplementary Planning Guidance* (GLA, 2012)[7]	Information on London Panoramas, Linear Views and River Prospects to inform the selection of viewpoints for the visual assessment.
Local authorities	Local Development Frameworks (LDFs), saved policies in *Unitary Development Plans (UDPs), Supplementary Planning Documents (SPDs)* and *Supplementary Planning Guidance (SPGs).*	Information on conservation areas, open spaces and designated viewpoints to inform both the townscape and visual assessment.
Local authorities	Conservation area appraisals	Information and mapping for conservation areas to inform the identification of townscape character areas and the townscape assessment.
Thames Strategy: Kew to Chelsea	*Thames Strategy: Kew to Chelsea* (Atkins, 2002)[8]	Information and landscape characterisation for the stretch of river from Kew to Chelsea, to help inform the identification of different character areas along the river for the townscape assessment.
English Heritage	National Monuments Record	Information on heritage assets including listed buildings to inform the townscape assessment.

11.4.3 Light detection and ranging (LiDAR) digital terrain models and digital surface models has been used to provide topographic information to identify the ZTV (defined in para. 11.5.5 for construction and para. 11.6.5 for operation). This establishes the assessment area for both townscape and visual.

Field survey baseline data

11.4.4 Field survey data used in the establishment of the townscape and visual baseline has been gathered through a range of surveys as described in Vol 2 Table 11.4.2 below.

Vol 2 Table 11.4.2 Townscape and visual – field survey baseline data sources

Source	Data	Notes
Townscape character area surveys	Information on the physical attributes of the townscape and the character of each townscape character area and photography for all character areas.	Undertaken to allow identification of townscape character areas (defined in para. 11.4.5). Photos of each townscape character area, included in the site specific volumes, have been provided for illustrative purposes only, and therefore are not identified on a location plan.
Winter visual field surveys	Information on the visual baseline and winter photography for all viewpoints.	Undertaken to allow identification of visual assessment viewpoints, checking of the ZTV and to inform assessment of the visual effects in winter.
Summer visual field surveys	Information on the visual summer baseline and summer photography for all viewpoints.	Undertaken to establish the visual characteristics of viewpoints in summer and undertake an assessment of the visual effects during summer (with the exception of sites where no operational visual assessment has been undertaken).
Verifiable photography	Verifiable photographs taken from each of the viewpoints agreed in advance with the local authority. The methodology for capturing verifiable photos is described in Vol 2 Appendix I.2.	Verifiable photographs were taken for the visual assessment in line with the requirements of the *LVMF* (described in Vol 2 Appendix I.2). Verifiable photographs were taken during daytime and night time for construction phase photomontages as required and during daytime for operational photomontages and also at night time where agreed with stakeholders. All verifiable photographs were taken during winter.

Source	Data	Notes
Verifiable surveying	Surveying of the camera location and photographic reference points was undertaken for each of the verifiable photography viewpoints. The methodology for verifiable surveying is described in Vol 2 Appendix I.2.	Surveying was undertaken for the visual assessment in line with the requirements of the *LVMF*.

Receptor identification and sensitivity

Townscape baseline

11.4.5 For the purposes of this project, the term townscape has been used throughout to describe urban areas, green open spaces (landscapes) and stretches of the tidal river (riverscape/seascape as defined by the Marine Management Organisation [HM Government , 2011][9]), to avoid the introduction of interchangeable and confusing terms.

11.4.6 The assessment area, for which the townscape baseline is described in and around each site, is defined in para. 11.5.4 for construction and para. 11.6.4 for operation.

11.4.7 The assessment of townscape character relies on an understanding of existing physical conditions within the defined assessment area, informed by policy designations such as conservation areas to allow largely homogenous areas of townscape to be identified. These areas are termed ‘townscape character areas’ and they form the receptors for the townscape assessment. The process for identifying and mapping TCAs is detailed in para. 11.4.9 to para. 11.4.12 below.

11.4.8 For each character area, character, condition and tranquillity have been described as well as the townscape value of the character area (these are further detailed in para. 11.4.13 to para. 11.4.18 below)

Mapping townscape character areas

11.4.9 In each site assessment volume (Vol 4 to 27), text and plans are used to describe the following physical characteristics (which make up the relevant townscape baseline elements as defined in the *GLVIA*):

a. topography

b. land use

c. development patterns and scale, including reference to building heights and heritage assets

d. vegetation patterns and extents, including Tree Preservation Orders (TPOs)

e. open space distribution and type, including statutory, non-statutory and local plan open space designations and with reference to the hierarchy of open spaces described in the *London Plan 2011*

f. transport routes.

11.4.10 The townscape baseline elements have been used to define townscape character areas, which display common features and characteristics, within the assessment area for each site. These character areas are also informed by statutory, non-statutory and local plan designations, particularly conservation areas. For the purposes of the assessment, the site is classified as a discrete area within the townscape.

11.4.11 For some sites, a series of sub-areas within each TCA have been identified to assist with describing which parts of a character area are most or least affected by the proposed development.

11.4.12 The site is defined by the limits of land to be acquired or used (LLAU). The character of the site is generally similar to or the same as the character of the surrounding townscape, but has been described and assessed separately as it defines the extent within which physical impacts on the townscape would occur.

Description of townscape character areas

11.4.13 The character of the site and surrounding townscape character areas has been described. Any designated areas that the site or character area falls within have been noted. Any particular components that make a substantial contribution to the character of the site, or surrounding townscape character area, have been noted and described, including listed buildings and structures and vegetation. Key characteristics of the setting of the character areas have also been described.

Determining townscape condition

11.4.14 Within the site, all above ground features and surface treatments, which may be physically impacted, have been described and their condition noted, with reference to the following categories, based on observations during site visits:

a. good condition – regularly maintained to a high standard

b. fair condition – relatively well maintained

c. poor condition – poorly maintained or damaged.

11.4.15 As surrounding townscape character areas would not be physically impacted, only the overall townscape condition has been described with reference to the categories described in para. 11.4.14.

Determining tranquillity of the townscape

11.4.16 With reference to the work of the Campaign to Protect Rural England (CPRE)[10], tranquillity can be defined as the sense of isolation from people, infrastructure and/or development, or lack of it, within a townscape. Tranquillity can be affected by the absence or presence of built development, traffic, people, vegetation and open spaces.

11.4.17 The baseline tranquillity of the site and surrounding townscape character areas has been described with reference to the following, based on observations during site visits:

a. type of land use
b. level of seclusion or isolation
c. extent and type of enclosure by surrounding land uses
d. level of screening afforded by vegetation, ground level change or boundary treatments
e. levels of vehicular traffic in, or close to the site
f. levels of pedestrian traffic in, or close to the site
g. the absence or presence of HGVs in, or close to the site
h. the absence or presence of major infrastructure routes in the vicinity of the site.

Determining townscape value

11.4.18 A description of the likely scale at which the townscape of the site and surrounding character areas is valued has been detailed. This is based on which users may value the site and, where available, statutory, non-statutory and local plan designations, in line with the *GLVIA*. Factors that influence the scale of townscape value are detailed in Vol 2 Table 11.4.3 below.

Vol 2 Table 11.4.3 Townscape – value scales

Scale of townscape value	Definition The site or townscape character area is:
International	Located within a World Heritage Site Considered an internationally important component of the country's character, experienced by significant numbers of international tourists.
National	Located within an Area of Outstanding Natural Beauty A nationally significant historic or cultural resource Considered a distinctive component of the country's character, experienced by significant numbers of tourists from around the country.
Regional	Located within green belt, Metropolitan Open Land (MOL) or a regional scale park Considered a distinctive component of London's character, experienced by a large proportion of the city's population.
Borough	Designated open space within the local authority *Unitary Development Plan (UDP)* or *Local Development Framework (LDF)* Designated as a conservation area Experienced by a significant proportion of the borough's

Scale of townscape value	Definition The site or townscape character area is:
	population.
Local	A public, semi-public or private open space that serves the local community or residents A residential area, likely to be valued by the local community.
Limited	A commercial, industrial or disused area that has limited townscape value to the local community or residents.

Determining townscape sensitivity

11.4.19 With reference to character, condition, tranquillity and value, the sensitivity of the site and surrounding townscape character areas to change has been determined. The determination of sensitivity requires the application of professional judgement using criteria developed from guidance in *GLVIA*. The presence of any combination of attributes may be considered when determining the sensitivity of the site or character area. This allows professional judgement to be used when determining the relative importance of different attributes, which varies on a site-specific basis. Attributes which contribute to the sensitivity of the site and surrounding character areas, informed by guidance in *GLVIA*, may include those detailed in Vol 2 Table 11.4.4 below. The occurrence of any one attribute may be sufficient to allocate the sensitivity rating. The full reasoning for the sensitivity designated to individual townscape character areas is provided in each site volume.

Vol 2 Table 11.4.4 Townscape – sensitivity criteria

Sensitivity	Definition The site or townscape character area:
High	Is valued at the borough scale or higher Is predominantly characterised by townscape components that are rare and distinctive and/or listed Is designated as a conservation area, registered park and garden or public open space Has a character that is rare within the assessment area Has a high level of tranquillity.
Medium	Is locally valued Has some components that are rare and/or distinctive Has a character which is common within the assessment area Has moderate levels of tranquillity.
Low	Has limited townscape value Has few or no distinctive components, or components that detract from the overall character of the site

Sensitivity	Definition The site or townscape character area:
	Has a character that is common within the assessment area Has limited tranquillity.

Visual baseline

11.4.20 The visual baseline is described with reference to viewpoints that are representative of views which people (visual receptors) may have of the proposed development during construction or operation.

11.4.21 All viewpoints are located within the ZTV, which has been checked on site to ensure it is an accurate indication of the theoretical visibility of the proposed development.

11.4.22 The assessment area for identifying visual receptors, is defined in para. 11.5.19 for construction and para. 11.6.13 for operation.

Identifying viewpoints

11.4.23 Viewpoints are selected to represent groups of receptors within the zone of theoretical visibility (see para. 11.5.5 for construction and para. 11.6.5 for operation). Before viewpoints were selected, the different visual receptors within the assessment area were mapped based on desktop research and site visits. Viewpoints were then selected to represent groups of visual receptors which have the same or a similar view towards the site, based on the following attributes:

a. theoretical visibility of a Thames Tideway Tunnel project site

b. protected views, identified in the London View Management Framework SPG, Local authority UDPs, LDFs and SPGs and conservation area character appraisals

c. consultation and feedback from local authorities and English Heritage

d. the receptor type

e. the extent of screening or filtering of the view (eg, by buildings or vegetation).

11.4.24 The location of each viewpoint has been confirmed in consultation with local planning authorities and English Heritage. These viewpoints have formed the basis for the visual assessment.

Description of visual baseline from each viewpoint

11.4.25 For each viewpoint, text and photos have been used to describe the baseline characteristics in winter. In each case, the following has been described:

a. the composition of the view, including foreground and background characteristics

b. the nature of the view of the site, including what, if anything, filters or screens the view and whether a view is a wide panorama, framed, glimpsed or sequential view.

11.4.26 Text and photos have also been used to describe the baseline characteristics in summer for all viewpoints included in the operational phase visual assessment. For sites where 24 hour lighting is anticipated during construction for durations in excess of four months, the baseline view at night is also described, noting levels and sources of existing lighting.

11.4.27 Photos included for each viewpoint are not panoramic photographs representing what is visible to the human eye. Where viewpoints have been selected to reflect the visibility of the site from tall buildings, a photo is included from public land close to the property, taken at ground level and a commentary included on the visibility of the proposed development from a higher elevation. Some visual receptor locations were not publicly accessible during the baseline surveys (for example the view from a base case scheme not yet built - see para. 11.4.33). In these instances, no photo has been included from these locations and professional judgement has been used to describe the view towards the site.

11.4.28 For sites where no substantial levels of lighting are anticipated during construction or operation, this is acknowledged in the site-specific volume and no description of the views during night time is included, except for sites where an assessment of operational phase lighting has been specifically requested by stakeholders.

11.4.29 Where viewpoints have been selected to reflect the visibility of the site from tall buildings, a photo is included from public land close to the property, taken at ground level and a commentary included on how the baseline view may appear from a higher elevation (including perceived scale and distance).

Determining sensitivity of visual receptors

11.4.30 The sensitivity of visual receptors is based on people's level of interaction with the townscape. Visual receptor types are considered by category in the following hierarchy according to criteria in the *GLVIA*:

a. high sensitivity – residential, recreational including tourists, where attention is focused on the surrounding townscape

b. medium sensitivity – transport, where views of the townscape are generally glimpsed.

c. low sensitivity - active sports, employment and other institutions, where attention is generally focused on the activity rather than on the wider townscape.

11.4.31 Where a viewpoint is located in an area that may represent multiple receptor types, the most sensitive receptor type is selected.

11.4.32 The sensitivity of a visual receptor remains the same in both summer and winter and during daytime and night time.

Base case

11.4.33 The base case for each site (defined in Section 3 General EIA methodology) is a projection of the likely baseline in the particular assessment year (ie, for the townscape and visual assessment the site year of peak construction activity and Years 1 and 15 of operation). This takes into account all relevant other developments in the assessment area that would be built and operational by the time of construction (in the case of the construction assessment) or operation (in the case of the operational assessment) of the Thames Tideway Tunnel project. Developments relevant to the base case are identified in project and site development schedules (see Vol 3 Appendix A.2 and Vols 4 to 27 Appendix N). The effect on townscape character and visual receptors has been described. The following are considered for each site:

a. How the relevant other developments between 2012 and the assessment year alter the character, condition, tranquillity or value and therefore sensitivity of the site or surrounding townscape character areas. Where this occurs, this is stated before making an assessment of effects.

b. How the relevant other developments between 2012 and the assessment year alter the visibility of the proposed development, through opening up or obscuring views. Where this occurs, this is stated before making an assessment of effects.

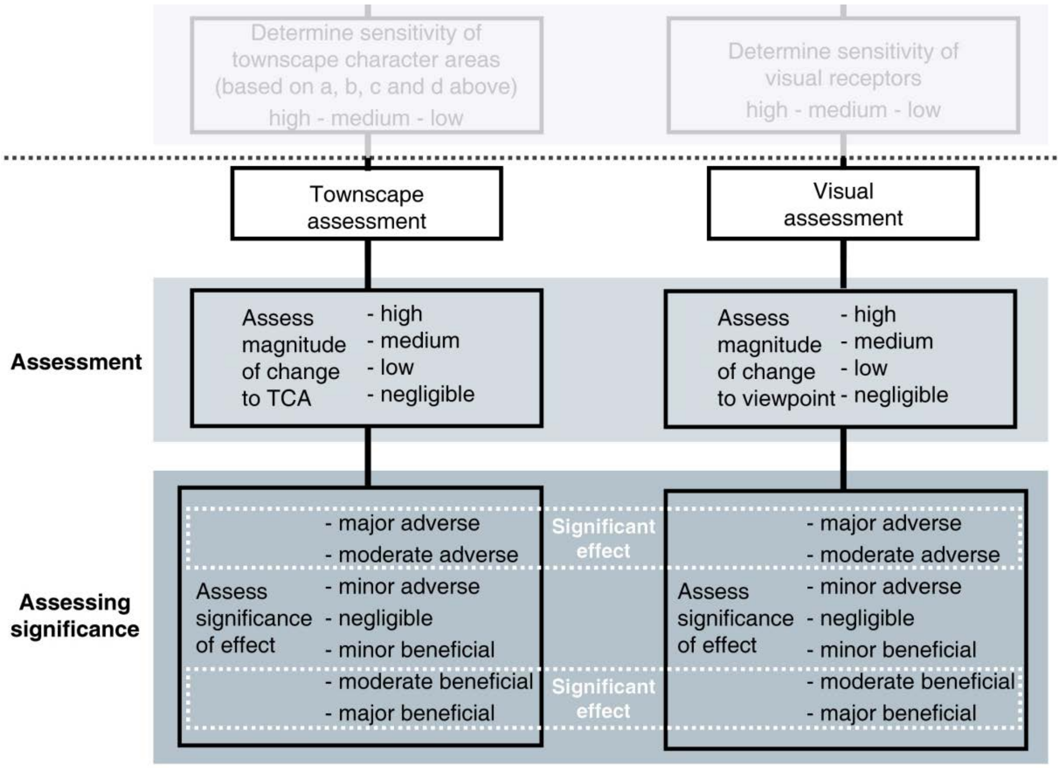
c. How the relevant other developments between 2012 and the assessment year introduce new visual receptors. Where this occurs, additional viewpoints may be added into the baseline for the site and the visual baseline described, as per para. 11.4.25 to para. 11.4.29 above and an assessment of effects is made.

11.4.34 Information on relevant other developments within the assessment area – as detailed in development schedules appended to each site assessment volume – has been gathered through a review of the respective Environmental Statement and descriptions of development in planning applications.

11.5 Construction effects assessment

11.5.1 This section sets out the methodology for assessing townscape construction effects followed by visual effects. The process for undertaking the townscape and visual assessment is summarised in Vol 2 Plate 11.5.1 below and which is explained in this section.

Vol 2 Plate 11.5.1 Townscape and visual – assessment process



11.5.2 The findings of the construction phase assessment have been iteratively fed back into the design process to minimise adverse effects wherever possible. This has included undertaking advance planting to reduce the visibility of construction activities and use of high quality hoardings appropriate to the character of the site and surrounding townscape.

Townscape assessment methodology

Assessment years

11.5.3 The assessment of townscape effects during construction has been undertaken for the peak construction year when the site is fully set up with the largest amount of construction plant on site, including welfare facilities, stock piling, cranes and road traffic movements. The particular peak year varies from site to site and is identified in each site assessment volume. In addition, consideration is given to the extent to which the construction and operational assessment findings would be likely to vary materially from those assessed should the programme for the Thames Tideway Tunnel project be delayed for approximately one year.

Assessment areas

11.5.4 The construction phase assessment area has been defined as the area over which the proposed construction activity could affect the character or setting of the site and surrounding character areas. The ZTV has been used as a tool to establish the extent of the townscape construction phase assessment area. Professional judgement has then been applied to interpret the model (described in para. 11.5.8), in line with guidance provided by *GLVIA*. All townscape character areas that lie partially or entirely within the construction phase ZTV (except in those location where the visibility is a false representation, or where the construction activity would be barely perceptible, as detailed in para. 11.5.8) form the extent of the assessment area, as the proposed construction activity may have an effect on their setting.

ZTV preparation process

11.5.5 The ZTV for each site has been created by digitally modelling the landform within the assessment area using a digital terrain model (ground profile) combined with building height information from a digital surface model. Building height information was extracted using the OS MasterMap buildings layer to filter out trees and other vegetation from the digital surface model, which inaccurately skew the results if left in. This is due to the model interpreting all information as a solid barrier, whereas trees generally filter visibility rather than obstruct, particularly during winter. Bridges across the River Thames (which appear in the digital surface model as solid objects) have also been manually removed from the model as views are typically present underneath the arches. If bridges are retained in the model, they falsely indicate no visibility from certain viewpoints. Professional judgement has been used to interpret this on site (described in para. 11.5.8).

11.5.6 To model the ZTV for construction, the maximum height of the tallest equipment to be used (typically cranes and/or noise sheds and silos) and the spatial area they may occupy in any possible configuration of the construction site has been incorporated into the model. An offset of 1.65m above ground level has been used to represent the eye level view of an average height person. The model highlights areas from which the proposed construction activity would be theoretically visible.

11.5.7 The results have been presented on an OS MasterMap base, overlaying the construction phase ZTV with the buildings layer, highlighting the visibility from people standing at ground level only. This prevents the ZTV from illustrating widespread visibility of the proposed construction activity from the roofs of buildings, which would be an inaccurate indication of the theoretical visibility of the project.

11.5.8 The validity of the ZTV has been checked on site, using professional judgement to ensure the output is a fair representation of the likely visibility of the proposed development. In a number of locations, such as on the foreshore of the River Thames and in large open spaces providing uninterrupted views, the ZTV generated by the model extends for long distances. In these instances, the extent has been checked on site to assess where the model is providing a false indication of the visibility of the proposed development. This may result from thick bands of vegetation, structures such as walls or embankments, or bridges that have been removed from the model (para. 11.5.5), or because the components of the proposed development (including cranes during construction) become barely perceptible in the background of the view, due to the distance between the site and receptor. The extent of the assessment area has then been reduced to reflect the likely visibility of the proposed construction activity.

Methodology

11.5.9 Townscape effects relate to changes in character arising from physical impacts (which would be limited to the LLAU) and changes to the setting of wider character areas partly or wholly located within the ZTV.

11.5.10 The townscape assessment has been undertaken for each character area within the construction phase assessment area. As described in para. 11.4.11, some character areas are sub divided to assist in the description of effects, however the assessment considers effects on the character of the townscape character area as a whole.

Significance criteria

11.5.11 The level of significance of effects on townscape receptors is derived from measures of the magnitude of effect and the sensitivity of the receptors affected as described below. These have been informed by guidance in the *GLVIA*.

Determining magnitude of impacts

11.5.12 The likely nature and magnitude of changes to individual townscape elements and characteristics have been described together with the consequential effect on townscape character. Within the site, physical changes, whereby townscape components are lost, damaged, improved or altered, may give rise to effects on the townscape character of the site and the setting of wider character areas. Factors that are considered in assessing the magnitude of change to the site and surrounding character areas (either beneficial or adverse) are summarised in Vol 2 Table 11.5.1 below, based on guidance from *GLVIA*.

Vol 2 Table 11.5.1 Townscape – impact magnitude criteria

Impact magnitude	Definition
High	Total loss of or major alteration to key characteristics or components of the site or setting of surrounding character areas. Addition of new features or townscape components that would substantially change the existing character of the site or setting of surrounding character areas. Introduction of elements that markedly alter the tranquillity of the site or surrounding character areas.
Medium	Partial loss of or alteration to one or more key characteristics or components of the site or setting of surrounding character areas. Addition of new features or townscape components that may be prominent, but are largely in character with the existing site or setting of surrounding character areas. Introduction of elements that noticeably alter the tranquillity of the site or surrounding character areas.
Low	Minor loss of or alteration to one or more characteristics or

Impact magnitude	Definition
	components of the site or setting of surrounding character areas. Addition of new features or townscape components that are in character with the existing site or setting of surrounding character areas. Introduction of elements that discernibly alter the tranquillity of the site or surrounding character areas.
Negligible	Very minor loss or alteration of inconspicuous characteristics or components of the site or setting of surrounding character areas. Addition of new features or townscape components that are largely inconspicuous and in character with the existing site or setting of surrounding character areas. Introduction of elements that make no perceptible change to the overall tranquillity of the site or surrounding character areas.

Determining significance of effects

11.5.13 Determination of the significance of an effect requires the application of professional judgement to weigh the findings of the sensitivity of the receptor and the magnitude of change.

11.5.14 This approach is recommended by *GLVIA* and further supported by the recent consultation draft of the revised guidance (Landscape Institute, 2012)[11], which recommends the use of professional judgement rather than a matrix approach to assessments (pages 92-96 of *GLVIA*). The presence of any combination of factors may be considered when assessing the significance of effect. This allows professional judgement to be used when determining the relative importance of different factors, which varies on a site-specific basis. Effects may be adverse or beneficial. The criteria that determine the level of significance of townscape effects are shown in Vol 2 Table 11.5.2 below. Both the major and moderate categories are considered to comprise a significant effect. Any one aspect described may result in a categorisation within that significance level.

Vol 2 Table 11.5.2 Townscape – significance criteria

Significance of effect	Description
Major adverse	Would be at considerable variance with the existing townscape character, degrading its integrity Would permanently degrade, diminish or destroy the integrity of valued characteristic features, elements and/or their setting Would be judged to be adverse at a national or regional level

Significance of effect	Description
	Would comprehensively conflict with regional or local environmental policies for the protection and enhancement of the townscape.
Moderate adverse	Would be at variance with the existing townscape character Would be judged adverse at a local level Would not be wholly compatible with local environmental policies for the protection and enhancement of the townscape.
Minor adverse	Would be slightly at variance with the existing townscape character.
Negligible	Would be compatible with the existing townscape character.
Minor beneficial	Would slightly improve and enhance the existing townscape character Would restore valued characteristic features partially lost through other land uses.
Moderate beneficial	Would markedly improve and enhance the existing townscape character Would restore valued characteristics substantially lost through other land uses.
Major beneficial	Would considerably and distinctly improve and enhance the existing townscape character Would restore valued characteristic features substantially or entirely lost through other land uses.

Visual assessment methodology

Assessment years

11.5.15 The assessment of visual effects during construction has been undertaken for the peak construction year when the site is fully set up with the largest amount of construction plant on site, including welfare facilities, stock piling, cranes and road traffic movements. The particular peak year varies from site to site and is identified in each site assessment volume.

11.5.16 For all sites an assessment of construction effects on visual receptors has been undertaken during winter when the screening effect of vegetation is limited and construction activity would be most visible. An assessment of construction effects has not been undertaken during summer as vegetation is in leaf and more likely to provide screening of construction effects.

11.5.17 Where 24 hour lighting is proposed during construction for durations in excess of four months, an assessment of visual effects during winter at night has been undertaken. This is the case at main drive sites, connection tunnel drive sites and some CSO interception sites which have short connection tunnels, which would have some 24 hour lighting of loading excavated material into road and river transport.

11.5.18 A summary of the temporal scope of the assessment for each site is provided in Vol 2 Table 11.5.5.

Assessment areas

11.5.19 The construction phase visual assessment area has been defined as the area over which the proposed construction activity could affect peoples' views of the townscape within the wider area. The ZTV has been used as a tool to establish the extent of the visual construction phase assessment area, alongside professional judgement which has been used to interpret the model (described in para. 11.5.8), in line with guidance provided by *GLVIA*. All viewpoints are located within the ZTV.

11.5.20 The ZTV has been prepared in line with the methodology described in para. 11.5.5 to 11.5.8.

Methodology

11.5.21 Visual effects relate to the changes that arise in the composition of available views, as a result of changes arising from the proposed development and the responses of people to these changes.

11.5.22 The assessment of visual effects has been undertaken with reference to representative viewpoints, using professional judgement, with reference to project descriptions and drawings including plans and visualisations.

11.5.23 In some locations the assessment of visual effects is supported by the production of verifiable photomontages during both daytime and night time. These have been selected in agreement with local planning authorities and English Heritage. Verifiable photomontages are accurately prepared visualisations of the proposed development which can be used to determine the view from a specific location. The verifiable photomontages show an illustration of how the construction sites may be set up during the peak construction phase. The layouts of the construction activities may change within the maximum extent of working area (see Construction phase plans [see Vols 4 to 27 volume of figures – Section 1]), however the assessment of effects based on the layout shown would be no worse than that described in the ES. These verifiable photomontages have been prepared for viewpoints where:

a. the receptor is highly sensitive to change and/or the viewpoint is identified in the London View Management Framework SPG, local authority UDPs, LDFs or SPDs/SPGs, or conservation area character appraisals

b. the magnitude of effect cannot be easily assessed with reference to plans and computer generated 3D visualisations (eg, where views may be partially filtered or screened by vegetation or built form, or where the precise siting of elements has a particular importance in relation to the composition of a view)

c. this has been specifically requested by a stakeholder.

11.5.24 The process for preparing verifiable photomontages is described in Vol 2 Appendix I.2.

Significance criteria

11.5.25 The level of significance is derived from measures of the magnitude of effect and the sensitivity of the receptors affected as described below. These have been informed by guidance in the *GLVIA*.

Determining magnitude of impacts

11.5.26 The factors that are considered in assessing the magnitude of change on visual receptors (either beneficial or adverse) are described in Vol 2 Table 11.5.3 below, based on guidance from *GLVIA*.

Vol 2 Table 11.5.3 Visual – impact magnitude criteria

Impact magnitude	Definition
High	Total loss of or major alteration to key characteristics of the view from a receptor. Addition of new features or components that are continuously highly visible and incongruous with the existing view from a receptor. Substantial changes in close proximity to the visual receptor, within the direct frame of view.
Medium	Partial loss of or alteration to one or more key characteristics of the view from a receptor. Addition of new features or components that may be continuously highly visible, but are largely characteristic of the existing view from a receptor. Changes are a relatively short distance from the receptor, but viewed as one of a series of components in the middle ground of the view. Substantial change partially filtered by intervening vegetation and/or built form, or viewed obliquely from the visual receptor.
Low	Minor loss of or alteration to one or more characteristics of the view from a receptor. Addition of new features or townscape components that may be continuously or intermittently visible, but are largely characteristic of the existing view from a receptor. Changes within the background of the view, viewed as one of a series of components in the wider panoramic view from a receptor. Change largely filtered by intervening vegetation and/or built form, or viewed obliquely from the visual receptor.
Negligible	Very minor loss or alteration of inconspicuous characteristics of the view from a receptor.

Impact magnitude	Definition
	Addition of new features or townscape components that are largely inconspicuous and characteristic of the existing site when viewed from a receptor. Changes within the background of the view, viewed as an inconspicuous element within the wider panoramic view from a receptor. Change from a visual receptor almost entirely obscured by intervening vegetation and/or built form.

Determining significance of effects

11.5.27 Determination of the significance of an effect requires the application of professional judgement to weigh the findings of the sensitivity of the receptor and the magnitude of change. This is consistent with the approach recommended by *GLVIA* (para. 11.5.14). The criteria that influence the level of significance of visual effects are shown in Vol 2 Table 11.5.4 below, derived from *GLVIA*. Both the major and moderate categories are considered to comprise a significant effect.

Vol 2 Table 11.5.4 Visual – significance criteria

Significance of effect	Description The proposed development would result in:
Major adverse	a marked deterioration in the existing view.
Moderate adverse	a noticeable deterioration in the existing view.
Minor adverse	a discernible deterioration in the existing view.
Negligible	no perceptible deterioration or improvement in the existing view.
Minor beneficial	a discernible improvement in the existing view.
Moderate beneficial	a noticeable improvement in the existing view.
Major beneficial	a marked improvement in the existing view.

11.5.28 Vol 2 Table 11.5.5 below summarises the assessments of construction effects for townscape and visual effects site by site.

Vol 2 Table 11.5.5 Townscape and visual – construction assessment of sites

Site	Construction (peak year)		
	Townscape	Visual (winter)	
		Daytime	Night time
Acton Storm Tanks	✓	✓	
Hammersmith Pumping Station	✓	✓	
Barn Elms	✓	✓	✓
Putney Embankment Foreshore	✓	✓	
Dormay Street	✓	✓	✓
King George's Park	✓	✓	
Carnwath Road Riverside	✓	✓ *	✓ *
Falconbrook Pumping Station	✓	✓	✓
Cremorne Wharf Depot	✓	✓	✓
Chelsea Embankment Foreshore	✓	✓	
Kirtling Street	✓	✓ *	✓ *
Heathwall Pumping Station	✓	✓ *	
Albert Embankment Foreshore	✓	✓	
Victoria Embankment Foreshore	✓	✓	
Blackfriars Bridge Foreshore	✓	✓	
Shad Thames Pumping Station	✓	✓	
Chambers Wharf	✓	✓	✓ *
King Edward Memorial Park Foreshore	✓	✓ *	
Earl Pumping Station	✓	✓	
Deptford Church Street	✓	✓ *	
Greenwich Pumping Station	✓	✓	✓
Abbey Mills Pumping Station	✓	✓	
Beckton Sewage Treatment Works			
Bekesbourne Street	✓	✓	

** indicates a construction phase verifiable photomontage has been prepared for this site*

11.6 Operational effects assessment

11.6.1 An operational phase assessment has not been undertaken for sites where it is considered there would be no significant effects (the justification for this is described in each site volume).

11.6.2 The findings of the operational phase assessment have been iteratively fed back into the design process to minimise adverse effects wherever possible. This has included planting of replacement trees, use of high quality materials for the river walls, above ground structures and public realm, suited to the character of the surrounding townscape and adjusting the location of foreshore structures, ventilation columns and electrical and control kiosks.

Townscape assessment methodology

Assessment years

11.6.3 For relevant sites, the townscape assessment has been undertaken for Year 1 and Year 15 of operation. The purpose of Year 15 of operation assessment is to assess the effect that vegetation established as part of the proposed development would have on townscape character. A summary of the temporal scope of the assessment for each site is provided in Vol 2 Table 11.6.1.

Assessment areas

11.6.4 The operational phase assessment area has been defined as the area over which the physical components or change caused by the introduction of the proposed development could affect the character of the site or the setting of surrounding character areas.

11.6.5 The process for creating the operational phase ZTV and identifying the assessment area follows the process described for the construction phase, described in para. 11.5.5 to 11.5.8. The heights and extents of the proposed development have been modelled, including the full extents of zones for any above ground structures and the extent of projections into the river from permanent foreshore structures.

11.6.6 The operational phase ZTV is shown overlying the construction phase ZTV in each site volume (defined in Section 11.5) to allow a comparison of the two assessment areas. The extent of this ZTV is substantially smaller than the construction phase ZTV because the above ground structures are lower in height than the equipment used during construction.

Methodology

11.6.7 The methodology for assessing townscape operational effects, including determining magnitude of impacts and significance of effects, follows the construction assessment methodology described in Section 11.5.

Significance criteria

11.6.8 The significance criteria applied to the assessment of construction effects also apply to the assessment of operational effects (Section 11.5).

Visual assessment methodology

Assessment years

11.6.9 For relevant sites (described in para. 11.6.1 and Vol 2 Table 11.6.1), a Year 1 of operation visual assessment has been undertaken during winter and summer. The purpose of also including the assessment during summer is to assess how the effect of the proposed development is altered by surrounding vegetation, therefore providing a year round assessment of the permanent development.

11.6.10 A Year 15 of operation visual assessment for relevant sites (described in para. 11.6.1) has been undertaken during summer only. This is to assess the screening effect that vegetation established as part of the proposed development would have.

11.6.11 During operation, it is not envisaged that there would be any significant effects arising from lighting. Therefore, no assessment has been undertaken at night time with the exception of sites where this has been requested by stakeholders.

11.6.12 A summary of the temporal scope of the assessment for each site is provided in Vol 2 Table 11.6.1.

Assessment areas

11.6.13 The operational phase assessment area has been defined as the area over which the physical components or change caused by the introduction of the proposed development could affect peoples' views of the townscape within the wider area. The process for creating the operational phase ZTV follows that described in para. 11.6.5 and para. 11.6.6.

Methodology

11.6.14 The methodology for assessing visual operational effects follows the construction assessment methodology described in Section 11.5.

11.6.15 As for construction (described in para. 11.5.23), the assessment of visual effects is supported by the production of verifiable photomontages during daytime and, where specifically requested by stakeholders, night time. The verifiable photomontages show an illustration of the site in Year 1 of operation. The layouts of the proposed development may change within the zones shown on the Site works parameter plans (see Volume 4 to 27 volume of figures – Section 1), however the assessment of effects based on the layout shown would be no worse than that described in the ES.

Significance criteria

11.6.16 The magnitude and significance criteria applied to the assessment of construction effects also apply to the assessment of operational effects (Section 11.5).

11.6.17 Vol 2 Table 11.6.1 below summarises the assessments of operational effects for townscape and visual effects site by site. The Year 1 and Year 15 of operation townscape assessment and visual assessment during daytime has been prepared for all sites where significant effects are considered possible. The Year 1 of operation visual assessment during night time has been undertaken for sites where this has been specifically requested by stakeholders.

Vol 2 Table 11.6.1 Townscape and visual – operational assessment of sites

Site	Operational assessment					
	Year 1				Year 15	
	Townscape	Visual			Townscape	Visual
		Winter		Summer		Summer - day
		Day	Night	Day		
Acton Storm Tanks	✓	✓ *		✓	✓	✓
Hammersmith Pumping Station						
Barn Elms	✓	✓		✓	✓	✓
Putney Embankment Foreshore	✓	✓ *		✓	✓	✓
Dormay Street	✓	✓		✓	✓	✓
King George's Park	✓	✓ *		✓	✓	✓
Carnwath Road Riverside	✓	✓ *		✓	✓	✓
Falconbrook Pumping Station	✓	✓		✓	✓	✓
Cremorne Wharf Depot	✓					
Chelsea Embankment Foreshore	✓	✓ *		✓	✓	✓
Kirtling Street	✓	✓ *		✓	✓	✓
Heathwall Pumping Station	✓	✓ *		✓	✓	✓
Albert Embankment Foreshore	✓	✓ *	✓ *	✓	✓	✓
Victoria Embankment Foreshore	✓	✓ *	✓ *	✓	✓	✓
Blackfriars	✓	✓ *	✓ *	✓	✓	✓

Site	Operational assessment					
	Year 1				Year 15	
	Townscape	Visual			Townscape	Visual
		Winter		Summer		Summer - day
		Day	Night	Day		
Bridge Foreshore						
Shad Thames Pumping Station						
Chambers Wharf	✓	✓		✓	✓	✓
King Edward Memorial Park Foreshore	✓	✓ *		✓	✓	✓
Earl Pumping Station	✓	✓ *		✓	✓	✓
Deptford Church Street	✓	✓ *		✓	✓	✓
Greenwich Pumping Station	✓					
Abbey Mills Pumping Station						
Beckton Sewage Treatment Works						
Bekesbourne Street						

** indicates an operational phase verifiable photomontage has been prepared for this site*

11.7 Cumulative effects assessment

11.7.1 The general approach to assessing cumulative effects is described in Vol 3. The specific approach for townscape and visual is described below. No cumulative effects are expected during the operation of the Thames Tideway Tunnel project because there would be limited levels of operational activity at each site. Therefore no operational cumulative effects assessment has been undertaken.

11.7.2 The assessment of cumulative effects during construction has been undertaken for the site peak year of construction, specified in each site volume. The construction phase cumulative assessment considers the effects of construction of the Thames Tideway Tunnel project in conjunction with all other relevant developments likely to be under construction at the same time within the construction phase assessment area for individual Thames Tideway Tunnel project sites. Developments beyond the construction phase assessment area have not been considered as there would typically be no visual connectivity between them and the Thames Tideway Tunnel project sites. A qualitative description of the accumulation of effects from the Thames Tideway Tunnel project and other relevant developments is presented in each site volume.

11.7.3 For sites where substantial construction activity associated with other developments is anticipated within the assessment area, an assessment is made of the potential for likely significant effects on receptors to be elevated. Cumulative effects may arise from visibility of construction plant and activity, demolition or site hoardings at multiple sites, or increased levels of construction traffic.

11.8 Project-wide effects assessment

11.8.1 As described in Volume 3 and para. 11.1.9, no project-wide townscape and visual effects are considered likely and have therefore been scoped out of the EIA.

11.9 Assumptions and limitations

11.9.1 This section details general assumptions and limitations associated with the townscape and visual assessment. Site-specific assumptions and limitations are detailed Vol 4 to 27 (townscape and visual section).

Assumptions

11.9.2 The assessment is based on professional judgement and takes into account both the adverse and beneficial contribution that new development can make upon the existing townscape character of the site, its environs and on the visual resource of surrounding receptors.

Limitations

11.9.3 During the baseline survey there were some areas which were inaccessible (eg, private land, commercial premises and residential buildings). In these instances, no photo has been taken due to a representative location not being accessible and professional judgement has been used to approximate the likely views from these locations.

11.9.4 The ZTVs have been generated using LiDAR topographic data from 2007, which was the latest data set readily and reasonably available for the assessment areas. It is acknowledged that changes in the assessment area through new development and/or demolition would not be included in the model. However, the ZTV has been checked on site to verify the accuracy as far as possible and further inform the selection of viewpoints.

11.9.5 Despite the limitations identified above, the assessment of townscape and visual effects is considered robust.

11.10 Mitigation

Construction

11.10.1 The Thames Tideway Tunnel project has been designed to minimise environmental effects and therefore the construction design, methods and site layouts take account of townscape and visual considerations including protection of trees, the use of high quality hoardings and the use of capped and directional lighting as set out in the *Code of Construction Practice (CoCP)*. Where such measures form part of the project, they are identified in Volume 1 (for the overall project) and Section 3 of Vol 4 to 27 (for each site) and have been considered as embedded measures within the assessment. The *CoCP* is provided in Vol 1 Appendix A. It contains general requirements (Part A), and site specific requirements (Part B).

11.10.2 Where the assessment indicates significant adverse effects, having taken account of embedded measures, it is typically the case that no further mitigation is possible for townscape and visual such as screening tall construction machinery on site.

Operation

11.10.3 The Thames Tideway Tunnel project has been designed to minimise environmental effects and therefore the design takes account of townscape and visual considerations including a commitment to a high quality design for above ground structures, river walls and public realm (described in the *Design Principles* document and which are summarised in Section 3 of Vol 4 to 27). The *Design Principles* report is provided in Vol 1 Appendix B. Where such measures form part of the project, they are identified and considered in line with para. 11.10.1 above.

11.10.4 Where the assessment indicates significant adverse effects, having taken account of embedded environmental design, it is typically the case that no further mitigation is possible for this topic.

11.11 Residual effects assessment

11.11.1 Where mitigation measures are proposed, residual effects are assessed by qualitatively describing how the findings of the main assessment would be altered.

11.11.2 Where no mitigation measures are proposed, the residual effects remain as identified through the relevant assessment (construction or operation).

References

[1] Landscape Institute and the Institute for Environmental Management and Assessment. *Guidelines for Landscape and Visual Impact Assessment.* Second Edition (2002).

[2] Department for Transport. *Design Manual for Roads and Bridges* (DMRB), Volume 11 Section 3 Part 5 'Landscape Effects' (1993).

[3] Mayor of London. *London View Management Framework Supplementary Planning Guidance* (March 2012).

[4] Defra. *National Policy Statement for Waste Water: A framework document for planning decisions on nationally significant waste water infrastructure (*February 2012). Available at: http://www.defra.gov.uk/publications/2012/02/09/pb13709-waste-water-national-policy-statement. Last accessed 20 July 2012.

[5] Department for Communities and Local Government. *National Planning Policy Framework* (March 2012). Available at: http://www.communities.gov.uk/documents/planningandbuilding/pdf/2116950.pdf. Last accessed July 20 2012.

[6] Mayor of London. *The London Plan 2011– Spatial Development Strategy for Greater London* (July 2011).

[7] Mayor of London. *London View Management Framework Supplementary Planning Guidance* (March 2012).

[8] Atkins. *The Thames Strategy: Kew to* Chelsea (June, 2002).

[9] HM Government. *UK Marine Policy Statement*. The Stationery Office. (March 2011).

[10] CPRE. *Developing an intrusion map of England*. Land Use Consultants. (August 2007).

[11] Landscape Institute (February, 2012). See citation above, pages 92-96.

This page is intentionally blank

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.02**

Volume 2: Environmental assessment methodology

Section 12: Transport

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

Hard copy available in

Box **16** Folder **A**
January 2013

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

This page is intentionally blank

Thames Tideway Tunnel

Environmental Statement

Volume 2: Environmental assessment methodology

Section 12: Transport

List of contents

Page number

List of plates

Page number

List of tables

Page number

12 Transport

12.1 Introduction

12.1.1 This section sets out the methodology for assessing the likely significant effects of the Thames Tideway Tunnel project on transport.

12.1.2 The methodology outlined in this section has been applied to all sites, unless otherwise indicated in the site assessment volumes. The methodology for assessing project-wide effects is also described.

12.1.3 The need for an assessment of transport effects results from the potential for the project to generate additional traffic on the highway network, create physical changes to pedestrian, cycle and highway networks and parking provision, generate additional patronage on public transport services and affect river vessel operations at certain sites.

12.1.4 The topic specific methodology presented in this section builds upon the general assessment methodology summarised in Section 3 of this volume and develops this to take account of the range of likely significant environmental effects on transport arising from the construction and operation of the project.

12.1.5 The assessment of transport effects has been carried out at both strategic and local levels.

12.1.6 At the strategic level, the assessment examines the project-wide effects on transport. It also examines the effects on a sub-area of central London where concurrent construction at the Victoria Embankment Foreshore and Blackfriars Bridge Foreshore sites may produce particular effects on the highway network. This assessment is reported in Section 12 of Vol 3.

12.1.7 At the local level, the assessment considers the effects that may occur in the vicinity of individual sites. These assessments are reported in Section 12 of Vol 4 to 27.

12.2 Engagement

12.2.1 The general approach adopted regarding engagement is summarised in Section 2 of this volume.

12.2.2 In order to inform the methodology for the transport assessment and assist in the refinement of the design and assessments, a range of transport technical and statutory stakeholders have been engaged in discussion.

12.2.3 Transport for London (TfL) has been engaged in its role as strategic transport authority for London. In this role, discussions have been held in relation to highway layout and operation, pedestrian and cycle networks, London Underground, London Overground and Docklands Light Railway (DLR) services, London bus services and passenger services on the River Thames.

12.2.4 Engagement has also taken place with each of the London local planning authorities (LPAs) along the route of the Thames Tideway Tunnel project. In relation to transport, the LPAs have been engaged in their roles as Local Highway Authority (LHA).

12.2.5 Engagement has also taken place with the Greater London Authority (GLA) and Port of London Authority (PLA) in relation to project-wide issues and with river service operators at sites where their operations could be directly affected.

12.2.6 Engagement has taken place in several stages which broadly comprise:

a. discussions on the scope of the transport assessment and the methodology to be used

b. workshops with TfL and LHAs to discuss proposals at each of the project sites in order to identify key issues and enable the design to respond to those

c. discussions with individual LHAs to ensure that local issues associated with project sites have been captured in the design and assessment

d. a series of workshops with TfL and the LHAs to discuss the draft assessments at each site

e. a series of technical discussions with TfL on the approach to strategic and local highway network modelling for the assessment.

12.2.7 The assessment has also taken account of comments made by stakeholders during the phase one, phase two, interim, targeted and Section 48 consultation periods.

12.2.8 The IPC also provided a range of comments on the *Scoping Report*, which are summarised in Vol 2 Appendix A.3. These relate mostly to transport of waste, consultation with relevant authorities, construction transport options and transport mitigation. These have been addressed in the *Environmental Statement*.

12.2.9 In the *Scoping Report*, transport effects associated with the operational phase of the project were scoped out of the environmental impact assessment (EIA). However, when discussing the scope of the *Transport Assessment* (the technical study supporting the assessment of transport effects in this report), it was agreed with TfL and the LHAs that the *Transport Assessment* (and also the *Environmental Statement*) should consider the transport requirements for the operational phase of the project in order to provide those stakeholders with technical justification for the proposals. Consequently, and in order to provide consistency, the outcomes of that work are reported within the transport sections of Vol 4 to 27 of this *Environmental Statement*.

12.2.10 Site-specific issues arising from the engagement with transport stakeholders are addressed in the transport sections of Vol 4 to 27 of this report. General issues which have emerged from the engagement with stakeholders and which are relevant to the assessment of transport effects arising from the project as a whole are summarised in Vol 2 Appendix J.1.

12.2.11 The key issues raised in relation to the transport assessment include the degree to which construction materials would be transported by river, the need for a defined logistics strategy and programme for assessment, the use of a consistent methodology for modelling effects on the highway network, agreed scenarios for traffic modelling, the implications of diverting pedestrian and cycle routes, considerations of pedestrian and cyclist safety in the vicinity of Thames Tideway Tunnel project sites, the level of provision of on-site parking for construction workers, the implications of temporary restrictions to on-street car and coach parking and the need to develop a Travel Plan (or plans) for workers travelling to and from sites.

12.3 Legislation and guidance

12.3.1 The *Transport Assessment* and assessment of the likely significant effects of transport in this *Environmental Statement* have been carried out with reference to the following guidelines:

a. Transport Assessment *Best Practice Guidance* (Transport for London, 2010)[1], which provides the basis for the information and technical analysis provided in the *Transport Assessment* and in this *ES*.

b. Institute of Environmental Management and Assessment (IEMA) *Guidelines for Environmental Assessment* (IEMA, 2006)[2], which have been used as the basis from which to derive many of the transport-related significance criteria for the assessment.

c. *Design Manual for Roads and Bridges* (Department for Transport, various dates)[3] guidance, which has informed the design of transport measures associated with construction activities.

d. *TfL Traffic Modelling Guidelines* (Transport for London, 2010)[4] and *Model Auditing Process* (Transport for London, 2011)[5], which set out methodologies for highway capacity modelling.

e. *Accessible Bus Stop Design guidance* (Transport for London, 2006)[6] published by TfL, which has informed the design of measures relating to bus infrastructure.

f. *London Cycling Design Standards* (Transport for London, 2012)[7] published by TfL, which have informed the design of measures relating to cycling.

g. *Walking Good Practice guidance* (Transport for London, 2010)[8] published by TfL, which has provided a basis for considering changes to pedestrian routes during construction.

h. Travel Plan guidance – Travel Planning for New Development in London (Transport for London, 2011)[9] and ATTrBuTE (Transport for London, 2012)[10], both published by TfL, which have informed the preparation of the *Draft Project Framework Travel Plan* and associated site-specific travel planning requirements and guidelines.

12.3.2 Vol 2 Table 12.3.1 presents the requirements within the *National Policy Statement (NPS) for Waste Water* (Department for Environment, Food and

Rural Affairs, 2012)[11] relevant to transport and explains how the requirements have been addressed within the ES. The table also gives the location of the relevant material.

Vol 2 Table 12.3.1 Transport – requirements of the NPS and how they have been addressed

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
The applicant's ES should include a *Transport Assessment*, using the NATA WebTAG methodology stipulated in Department for Transport guidance, or any successor to that methodology	The application includes a full *Transport Assessment* which examines both project-wide and site-specific assessments. It is based on TfL guidance on transport assessments for developments in London, which is considered to be the most relevant guidance for this assessment and this approach has been agreed with TfL and the Local Highway Authorities	*Transport Assessment* Sections 1 to 27
The applicant should consult the relevant highway authority on the assessment and on mitigation measures	TfL as strategic highway and transport authority for London, and the relevant local highway authorities, have been consulted on the scope of the transport assessment, the methodology and measures relevant to transport which have been embedded in the design of the project	Section 12 of Vol 3 and Section 12 of Vol 4 to 27 of the *ES* Sections 1 to 27 of the *Transport Assessment*
The applicant's assessment should distinguish between the construction, operation and decommissioning project stages as appropriate	The *Transport Assessment* and the assessment of transport effects in the ES address the construction phase and where relevant, the operational phase. As decommissioning of the project infrastructure is not anticipated, the decommissioning phase has not been considered within the ES / *Transport Assessment*.	Section 12 of Vol 3 and Section 12 of Vol 4 to 27 of the *ES* Sections 1 to 27 of the *Transport Assessment*

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
The applicant should prepare a travel plan including demand management measures to mitigate transport impacts. The applicant should provide details of proposed measures to improve access by public transport, walking and cycling, to reduce the need for parking associated with the proposal and to mitigate transport impacts.	A *Draft Project Framework Travel Plan* has been developed for the project as a whole. It includes guidelines and requirements for contractors to prepare site-specific Travel Plans within this framework. It also sets out the range of measures which could be used at sites to reduce the number of workers travelling by private car. Parking for workers would not generally be provided at project sites, other than at Abbey Mills Pumping Station and Beckton Sewage Treatment Works which are existing Thames Water facilities.	*Draft Project Framework Travel Plan*
The decision maker should ensure that the applicant has sought to mitigate impacts. Where mitigation is needed, possible demand management measures must be considered and, if feasible and operationally reasonable, required, before considering requirements for the provision of new inland transport infrastructure.	The design of the project incorporates a range of physical measures necessary to address potential impacts at individual sites. This includes the *Code of Construction Practice (CoCP)* (Section 5) which contain measures that would be used to manage demand and minimise disruption to the transport networks during construction.	*CoCP* (Section 5). The *CoCP* is provided in Vol 1 Appendix A. It contains general requirements (Part A), and site specific requirements (Part B). Plans referred to within the *Transport Assessment* and Section 12 of Vol 3 and Section 12 of Vol 4 to 27 of the *ES*
The decision maker should consider that water-borne or rail transport is preferred	A *Transport Strategy* has been developed based on detailed consideration of environmental, economic	*Transport Strategy*

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
over road transport, where cost-effective.	and social issues together with operational feasibility, cost and risk. The *Transport Strategy* assumes the use of the river to transport a proportion of construction materials at 11 of the 24 project sites and reflects the guidance of the NPS in this respect.	
Where there is likely to be substantial HGV traffic, **applicants** should look to control numbers of HGV movements in a specified period during construction and possibly the routing of such movements; make sufficient provision for HGV parking to avoid overspill parking on local roads or prolonged queuing on approach roads; and ensure satisfactory arrangements for reasonably foreseeable abnormal disruption	Measures set out in Section 5 of *CoCP Part A* and *Part B* include requirements to manage lorry movements and to specify routes for construction vehicles. Contractors would be required to produce a *Traffic Management Plan* for each site to develop the *CoCP* measures in detail.	*CoCP* Part A and Part B (Section 5)

12.4 Baseline data collection

12.4.1 Existing transport conditions at each of the sites have been established and agreed with TfL and the LHAs to provide baseline data for the assessment.

12.4.2 Baseline conditions have been identified using site visits, desk based collation of available information from TfL and the LHAs, on-site field survey data collection and local modelling. For the site-specific assessments, only those transport modes which are present in the vicinity of the sites have been considered.

Pedestrian and cycle networks

12.4.3 Baseline data collection has identified existing walking and cycling networks and facilities, including pedestrian crossings, cycle routes and cycle parking in the vicinity of each site.

12.4.4 The networks have also been considered in the context of the linkages which they provide for pedestrians and cyclists moving through and around each construction site and the degree of connectivity to other transport modes and to facilities and services.

12.4.5 Pedestrian and cycle flows have been derived primarily from field survey sources.

12.4.6 At sites with significant levels of pedestrian activity in the surrounding area, a pedestrian Level of Service (LoS) assessment has been undertaken where possible, based on the criteria established by Fruin (Fruin, JJ, 1971)[12] for describing the operation of pedestrian footways under different levels of pedestrian demand.

Public transport networks

12.4.7 Existing public transport services operating in the area surrounding each site have been identified. Wider public transport network operations, where these are relevant to the project-wide assessment, have also been considered.

12.4.8 Information has been obtained on the routes and service frequencies available at nearby National Rail, London Overground, London Underground and DLR services.

12.4.9 Details of existing bus routes and frequencies have been compiled, together with details of existing bus stop and stand locations in close proximity to each of the sites.

12.4.10 Details of any specific taxi infrastructure, such as rank locations, have been collated.

12.4.11 Existing river passenger services operating in the surrounding and wider area have been identified. This includes information on the frequency of services and locations of piers relevant to each construction site. Information on the levels of use of the river for commercial and leisure purposes have also been obtained.

12.4.12 The Public Transport Accessibility Level (PTAL) at each of the proposed sites has been determined. This is particularly relevant to the range of transport choices available to construction personnel travelling to and from each site. PTAL values also provide background information on the relative importance of each location in the context of wider travel within London.

12.4.13 PTAL calculations have been undertaken using the standard PTAL methodology described in the Transport Assessment *Best Practice Guidance* (TfL, 2010)[13]. Reference has also been made to the PTAL calculator within the TfL Planning Information Database online[14].

Highway network and parking

12.4.14 The road hierarchy, authority responsibilities and key elements of the surrounding highway network have been identified for each site.

12.4.15 Existing traffic conditions on the local highway network have been established from data collected from field surveys and from existing traffic models and traffic count information held by TfL and the LHAs.

12.4.16 Existing access provision for private parking and servicing at properties adjacent to the construction sites has been identified from site visits to ensure that any effects on access to these properties are identified as part of the assessment.

12.4.17 On-street parking at or adjacent to the proposed sites has been identified from site visits. This includes the level of provision for both permit and non-permit holders, the presence of Controlled Parking Zones (CPZs) and associated time restrictions, motorcycle parking and parking for blue badge holders.

12.4.18 Where appropriate, existing coach parking facilities for passenger set-down and pick-up and vehicle layover have been identified as part of the baseline. On-street loading bay provision and controls have also been identified.

12.4.19 Additionally, accident data for the most recent five year period available has been collated for the local roads in the vicinity of each of the sites.

Desk based baseline data

12.4.20 Information has been sought from available sources within TfL and the LHAs, and other reliable published sources where appropriate. Vol 2 Table 12.4.1 details the information which has been collected and reviewed.

Vol 2 Table 12.4.1 Transport – desk based baseline data sources

Source	Data	Notes
TfL	Accident record data	Sourced via TfL from police database records.
TfL	Bus route and timetable information	Sourced from TfL website[15].
TfL	Bus timetable and patronage information	Sourced from TfL Bus Origin Destination Survey (BODS) database.
TfL	Rail timetable information	Sourced from TfL website.
TfL	River passenger service timetable and patronage information	Service information sourced from TfL website.
TfL and LHAs	Pedestrian and cycle flow information	Information from TfL count databases and other

Source	Data	Notes
		information relating to development in the vicinity of sites (eg, *Transport Assessments* supporting planning applications).
TfL, LHAs and other published sources	Pedestrian and cycle route networks	Information from TfL website and cycle guides, Sustrans website[16] and Walk London website[17].
TfL and LHAs	Parking controls	Location of Controlled Parking Zones and hours of operation based on information available from LHAs.
TfL and LHAs	Traffic flow data	Information from TfL count databases and other information relating to development in the vicinity of sites (eg, *Transport Assessments* supporting planning applications).
TfL	Strategic highway assignment models (HAMs)	Use of TfL strategic models to support analysis underlying this assessment.
TfL	Local traffic models	Use of local junction models to provide additional information on traffic demand and junction operation to support analysis underlying this assessment.
TfL	Traffic signal data	Traffic signal layout and operational data to inform local junction modelling.

Field survey baseline data

12.4.21 A programme of field survey data collection was developed to provide comprehensive current information on traffic, pedestrian and cycle flows and parking usage in the vicinity of each of the sites. Fieldwork was primarily undertaken between May and July 2011. School and public holiday periods were excluded from the data collection; with the exception of automatic traffic count data which were collected both during school term and school holiday periods to provide a background comparison.

12.4.22 Further field survey work was undertaken in August 2011 at a number of locations to collect pedestrian flow data and provide information on pedestrian activity during the summer holiday period.

12.4.23 A third set of field data were gathered in May and June 2012 to provide additional traffic, pedestrian and river usage information, including coverage of locations where surveys had not been possible or appropriate in earlier tranches of survey work.

12.4.24 The scope of the field survey work was informed by the availability of data from the desk based sources described in Vol 2 Table 12.4.1.

12.4.25 Field survey data collection covered the topics shown in Vol 2 Table 12.4.2. The scale of the data collection required varied from site to site and not all of the data sources illustrated in the table below were necessary in all locations. The field surveys undertaken in relation to each site are detailed in Vol 4 to 27.

Vol 2 Table 12.4.2 Transport – field survey baseline data sources

Source	Data	Notes
Commissioned field surveys	Manual classified vehicle turning counts at junctions	Undertaken either by video observation or manual data collection.
Commissioned field surveys	Automatic volumetric vehicle counts	Undertaken using the temporary installation of automatic traffic count (ATC) equipment.
Commissioned field surveys	Pedestrian and cycle flow surveys	Undertaken by video observation or manual data collection at junctions and on other key walking and cycling routes.
Commissioned field surveys	Queue length surveys	Undertaken by video observation or manual data collection at junctions.
Commissioned field surveys	Saturation flow measurements	Undertaken by manual data collection at traffic signal junctions.
Commissioned field surveys	Parking surveys	Undertaken by manual data collection.

12.4.26 Data collection covered the key peak and off-peak time periods required for the assessment as follows:

a. weekday morning peak period (AM peak)

b. weekday daytime off-peak period (inter peak)

c. weekday evening peak period (PM peak)

d. weekend peak period

e. weekday night time period.

12.4.27 Other than in exceptional circumstances, vehicle movements at all sites would be limited to the period during the typical day shift of ten hours on weekdays (08:00 to 18:00) and five hours on Saturdays (08:00 to 13:00), with up to one hour before and after these hours for mobilisation and demobilisation of staff.

12.4.28 Appropriate peak, off-peak and night-time periods for survey and assessment were discussed with TfL and the LHAs.

12.4.29 The field survey work was undertaken by specialist traffic survey subcontractors working to an agreed methodology and programme. Field data were collated to produce coordinated baseline traffic, pedestrian and cycle flow information in the vicinity of each site.

12.4.30 This field information has been combined with information available from the desk based sources to produce a comprehensive baseline dataset for each construction site. A *Baseline Data Report* has been issued to TfL and the LHAs containing this information, which has been discussed with TfL and the LHAs. The *Baseline Data Report* forms an appendix to the *Transport Assessment*.

Highway network baseline modelling

Strategic level

12.4.31 The approach to modelling the highway network at a strategic level is based on the use of existing TfL strategic Highway Assignment Models (HAMs)[i]. This assessment has used three of the five HAMs, those for west, central and east London, which cover the locations of all of the Thames Tideway Tunnel project sites and this approach has been agreed with TfL. These models are used by TfL to predict future highway network conditions and have been developed using GLA employment and population forecasts, which are based on the employment and housing projections set out in the *London Plan 2011* (GLA, 2011)[18].

12.4.32 The TfL HAMs have base years of 2008 / 2009 which for the purposes of this assessment have been taken as being equivalent to baseline conditions.

12.4.33 The HAMs represent peak hours of 08:00 to 09:00 and 17:00 to 18:00 and these have been taken as being the network-wide peak hours in the project-wide and site-specific assessments.

12.4.34 Given that the effects of the Thames Tideway Tunnel project have been assessed by comparing a base case (without the Thames Tideway Tunnel project) against a development case (assuming the project is under construction) and that the 2021 TfL HAMs exist representing a base case for the assessment, the 2008 / 2009 baseline models have not been used directly in the future year modelling.

---

[i] The TfL highway assignment models used in the assessment are the West London Highway Assignment Model (WeLHAM), the Central London Highway Assignment Model (CLoHAM) and the East London Highway Assignment Model (ELHAM), all of which use the SATURN modelling software. The North London Highway Assignment Model (NoLHAM) and South London Highway Assignment Model (SLoHAM) have not been used for this assessment.

Local level

12.4.35 For the highway network, local junction capacity models have been developed for relevant locations in the vicinity of each of the sites.

12.4.36 Baseline models have been developed using appropriate junction modelling software[ii]. Where appropriate and possible, suitable existing models and signal timing information from TfL have been used. Where new models have been developed these have been based on observed data. *TfL Modelling Guidelines* (TfL, 2010)[19] and *Model Audit Processes* (TfL, 2011)[20] have been used as the basis for preparing and checking models and their outputs. Validation of the models has been based on observed data including signal timings, traffic volumes and queue lengths.

12.4.37 The baseline models provide a platform from which local construction base case models have been developed, as described in paras. 12.4.54 and 12.4.59, to inform the assessments of the effects of the Thames Tideway Tunnel project on the local highway network around each site.

Receptor identification and sensitivity

12.4.38 The *Guidelines for Environmental Assessment* (IEMA, 2006)[21] identify groups and special interests which should be considered within the assessment. These are:

a. people at home and in work places

b. sensitive groups including children, the elderly and disabled

c. sensitive locations, eg, hospitals, churches, schools, historical buildings

d. people walking and cycling

e. open spaces, recreational sites, shopping areas

f. sites of ecological / nature conservation value.

12.4.39 Against this background and the fact that the greatest impacts from this project are likely to arise from construction activity, typical receptors considered in the transport assessment fall into the following categories:

a. resident occupiers in properties surrounding the sites

b. business, education and workplace occupiers in the area surrounding the sites

c. pedestrians and cyclists travelling within and through the area surrounding the sites, including users of recreational spaces and with particular reference to sensitive pedestrian groups such as children, the elderly and those with mobility impairments

d. private vehicle users travelling or parking on the highway network in the area surrounding the sites

---

[ii] Local junction modelling has been undertaken using PICADY (for unsignalled priority junctions), LinSig (for individual or closely-linked signal junctions) and TRANSYT (for local networks of traffic signal junctions) software as appropriate.

e. emergency services requiring access within or passing through the area surrounding the sites

f. service vehicle operators using loading bays on streets in the vicinity of the sites

g. public transport users (passengers) travelling to, from and through the area surrounding the sites

h. public transport operators (including coach operators) whose operations may be affected by changes to services as a consequence of route diversions or changes to journey times

i. river vessel operators (including marine emergency services) and leisure users of the river whose activities may be affected by construction barge movements or restrictions on access to the foreshore as a result of construction.

12.4.40 The relevant receptors are detailed as part of the baseline assessment for each site and their likely levels of sensitivity in that location are identified. The generic receptor sensitivity criteria for the transport assessment are shown in Vol 2 Table 12.4.3. These are based on professional judgement of the sensitivity of the different receptors in the context of transport networks and activity along the route of the Thames Tideway Tunnel project.

12.4.41 The sensitivity of a given type of receptor may vary depending upon the distance of the receptor from the site in question. Typically, building occupiers beyond a distance of approximately 250m from a site are unlikely to be significantly affected, in terms of access and movement, by activity at that construction site. The sensitivity of receptors such as transport network users and operators would also tend to decrease with distance from the site, although consideration has been given to whether an effect in one location might create consequent effects on these receptors elsewhere on the relevant network.

12.4.42 The sensitivity of a given type of receptor may also vary from location to location depending upon the context of the area under assessment.

Vol 2 Table 12.4.3 Transport – typical receptor sensitivity criteria

Receptor value and/or sensitivity	Definition
High	• Residents living close to construction sites (including those on houseboats) • All emergency services (including marine emergency services) • Pedestrians and cyclists using routes or recreational spaces immediately adjacent to construction sites • All sensitive pedestrian users (children, elderly, mobility impaired), including those at educational facilities

Receptor value and/or sensitivity	Definition
	• Leisure users of the River Thames.
Medium	• Business occupiers close to construction sites • Residents living close to construction vehicle routes but at a distance from construction sites • Private vehicle users on the network adjacent to construction sites • Public transport users on services passing construction sites • River vessel operators.
Low	• Business occupiers adjacent to construction routes but at a distance from construction sites • Private vehicle users on the wider highway network • Service vehicle operators using loading bays • Public transport users on the wider network • Public transport operators.

Base case

Construction base case

Strategic level

12.4.43 The construction base case for the strategic assessment of the highway network has been prepared using the existing TfL HAMs as described in paras. 12.4.31 to 12.4.34.

12.4.44 The TfL HAMs have base years of 2008 / 2009 and a forecast year of 2021.

12.4.45 In order to provide consistency between this assessment and the work already done by TfL, it has been agreed with TfL that the 2021 forecast year from the HAMs would be used to represent the construction base case when assessing the strategic effects of Thames Tideway Tunnel project construction activity on the highway network (regardless of the assessment year being considered).

12.4.46 This approach is considered to be robust and appropriate given that:

a. peak construction activity at individual sites and project-wide is generally expected to occur in or before 2021 and therefore the construction base case is not likely to underestimate highway conditions during periods of peak activity.

b. the average traffic growth rate per annum is generally less than 1% which suggests that overall year-on-year changes are likely to be small.

c. the timing of implementation of developments and infrastructure schemes may vary within the period to 2021 as a result of a range of factors unrelated to and outside the control of the Thames Tideway Tunnel project.

d. other developments not included in the TfL 2021 forecast year HAMs in sufficient local detail have been addressed at the local level where they are most likely to influence base case conditions.

12.4.47 The construction base case for strategic and local modelling does not include any traffic related to the Thames Tideway Tunnel project.

12.4.48 A review has been undertaken of other developments within 1km of each site in order to identify those which are likely to be complete and operational by the construction base case year and should therefore be taken into account in the base case. Details of these schemes are set out in the development schedules (Appendix N in Vol 4 to 27). Construction traffic associated with other developments under construction at the same time as construction works at the Thames Tideway Tunnel project sites is considered as part of the cumulative effects assessment (see Section 12.7).

12.4.49 In the event that these other developments are not contained in the TfL 2021 forecast year HAMs, or that the HAMs do not provide a sufficiently detailed representation of significant developments at the local level around a particular project site, the local highway modelling (see para. 12.4.59) has taken account of specific local changes that might affect the assessment.

12.4.50 The strategic level assessment has focussed on the highway network but the strategic highway modelling has also allowed the effects of additional congestion or delay on bus services and other road-based transport to be identified. Effects on other modes of transport are considered most likely to be evident locally and are not expected to be significant at the strategic level.

Local level

12.4.51 The construction base case for the local level assessment requires the consideration of public transport, pedestrians, cyclists, public transport and the highway network.

12.4.52 Base case conditions for pedestrians and cyclists take into account definitive proposals to change these networks where relevant. Where a baseline LoS assessment has been undertaken, a corresponding base case LoS assessment has been prepared.

12.4.53 As part of baseline data collection, planned commitments to public transport infrastructure or service improvements have been identified. These are generally intended to increase public transport capacity to either meet general growth in public transport demand (patronage) or to provide significant enhancement on particular routes.

12.4.54 Future patronage changes are driven by a range of complex factors and there are inherent uncertainties in setting a patronage level for a future year. Therefore, in order to ensure that the busiest base case scenario has been used when assessing the impact of additional construction worker journeys by public transport, the capacity for bus, rail and river services in the construction base case has been assumed to remain the same as the capacity in the current baseline situation. This means that the assessment takes no advantage of any additional capacity that might become available in future years and is therefore considered robust.

12.4.55 For the highway network, local junction capacity models for the construction base case have been created by applying traffic growth factors derived from the TfL HAMs for each local authority to the baseline models described in paras. 12.4.36 to 12.4.37. Growth factors have been derived for each borough by comparing the 2008/9 baseline and 2021 forecast modelled years in the HAMs and this approach has been agreed with TfL.

12.4.56 These growth factors therefore include changes in traffic as a result of development and infrastructure schemes included within the HAMs (WeLHAM, CLoHAM and ELHAM) and are shown in Vol 2 Table 12.4.4.

Vol 2 Table 12.4.4 Transport – growth in vehicle kilometres

London Borough	AM peak hour			PM peak hour		
	WeLHAM	CLoHAM	ELHAM	WeLHAM	CLoHAM	ELHAM
City of London	n/a	1.9%	8.4%	n/a	8.4%	7.1%
Ealing	3.2%	0.3%	n/a	3.9%	4.5%	n/a
Greenwich	n/a	3.1%	6.8%	n/a	2.3%	4.5%
Hammersmith and Fulham	5.8%	6.5%	n/a	5.4	7.4%	n/a
Kensington and Chelsea	10.7%	9.9%	n/a	14.9%	16.4%	n/a
Lambeth	1.8%	9.1%	n/a	3.0%	11.2%	n/a
Lewisham	n/a	n/a	2.6%	n/a	n/a	3.1%
Newham	n/a	n/a	11.7%	n/a	n/a	12.6%
Richmond upon Thames	1.5%	-0.6%	n/a	-1.5%	-0.2%	n/a
Southwark	n/a	13.6%	3.8%	n/a	12.3%	4.4%
Tower Hamlets	n/a	7.5%	11.1%	n/a	9.7%	11.2%
Wandsworth	3.6%	4.0%	n/a	4.6%	5.3%	n/a
City of Westminster	7.4%	4.7%	n/a	6.0%	6.1%	n/a

Note: Table shows % change in total vehicle km from 2008/9 to 2021 modelled years in the HAMs. Where n/a is shown, the authority area is not within the simulation area of the particular HAM.

12.4.57 Vol 2 Table 12.4.4 shows that the growth factors typically represent growth of between 3% and 16% in AM peak (07:00 to 10:00), interpeak (10:00 to

16:00) and PM peak periods (16:00 to 19:00) over a 12 to 13 year period, or an average of around 0.2% to 1% per annum.

12.4.58 By using these growth factors, the local construction base case highway models represent conditions in 2021 and provide consistency with the strategic construction base case modelling. This has allowed iteration between the strategic and local modelling analysis. The use of these 2021 base case models in creating development cases is described further in para. 12.5.39 to 12.5.43.

12.4.59 Where necessary, physical and traffic demand changes associated with other developments or infrastructure changes which are not already included in the TfL 2021 forecast year HAMs have been incorporated in the local construction base case models in addition to the traffic growth factors from the TfL sub-regional models.

Additional receptors

12.4.60 The nature and anticipated completion date of other developments within 1km of each project site was reviewed (see para. 12.4.48) to determine whether any additional receptors should be considered within the base case for the assessment of transport effects. As para. 12.4.41 explains, building occupiers beyond a distance of 250m from the site are unlikely to be significantly or directly affected by construction activity in terms of transport. The sensitivity of transport users to construction effects also tends to decrease with distance from the site. Generally, therefore, additional receptors have only been identified if they would lie within 250m of a project site.

12.4.61 Where necessary, relevant additional receptors have been considered and are identified in Vol 4 to 27 of the *Environmental Statement.*

Operational base case

12.4.62 During operation of the Thames Tideway Tunnel project the only transport activities expected would relate to maintenance and inspection of equipment, shafts and tunnels. It is therefore anticipated that there would be no significant effects on transport, either strategically or locally, as maintenance trips to the site would be infrequent and short-term.

12.4.63 As agreed with TfL and the LHAs, it has therefore not been necessary to undertake a quantitative evaluation of the effects on the highway or other networks. On this basis the operational base case has been assumed to be the same as the construction base case, except in locations where known changes arising from other development need to be taken into account.

12.4.64 The anticipated completion date of other developments in the area surrounding construction sites has been reviewed and where appropriate, additional receptors applicable to the operational base case have been identified.

12.5 Construction effects assessment

12.5.1 This section describes the methodology for the assessment of transport effects during construction. The assessment examines the likely significant construction effects of the project on transport at three levels:

a. site-specific (local level) assessments: these identify the effects on all relevant receptors as a result of the impacts of the project on the transport networks around each of the individual sites. These assessments are contained within the site-specific assessments in Vol 4 to 27 of the *ES*.

b. an assessment of a sub-area of central London around the Victoria Embankment Foreshore and Blackfriars Bridge Foreshore sites to examine the effects specifically on the highway network arising from concurrent construction activity at those sites. This assessment is contained in Vol 3 as a strategic level assessment.

c. project-wide (strategic level) assessment: this identifies the effects on relevant receptors as a result of the impacts of the all project sites on the strategic transport networks. This assessment is contained in Vol 3 and comprises an assessment across the entire project area as well as 'cluster' assessments in western, central and eastern regional areas.

12.5.2 This section describes the relationship between these three levels and sets out the site-specific methodology in more detail.

Assessment years

12.5.3 The duration and nature of construction activity would vary from site to site and not all sites would experience peak activity at the same time within the overall construction programme.

12.5.4 The assessment years at strategic and local levels therefore differ, as the project-wide peak activity (strategic level) would not necessarily be concurrent with the date of peak activity at individual sites. Furthermore, local assessments have addressed different years depending upon the expected site-specific peak activity date in each location.

12.5.5 At the site-specific level, the period in which the number of construction lorry movements is expected to be greatest has been used for the assessment. This has been identified from the *Transport Strategy*. These periods vary from site to site depending upon the nature and duration of work required and the position of site works within the overall project programme.

12.5.6 In addition, consideration has been given to the extent to which the construction assessment findings would be likely to vary materially from those assessed should the programme for the Thames Tideway Tunnel be delayed by approximately one year.

Assessment areas

12.5.7 For each site, the assessment area has been defined in consultation with the relevant LHA and with TfL. The assessment areas include the site access locations and immediately adjacent junctions and, as a minimum, the construction vehicle route between the site access and the first junction on the TfL Road Network (TLRN) or Strategic Road Network (SRN). The assessment areas have informed the geographic scope of data collection.

12.5.8 The extent of the assessment area for local highway network modelling has been informed by considering the volume of construction traffic at each site and the significance of the effects that would be experienced at the nearest junction of the construction vehicle route with the TLRN or SRN. Where the assessment indicates that the effects at this junction would not be significant, junctions further afield on the network have not been assessed. Where this is not the case, a wider area of the local highway network has been considered in the assessment.

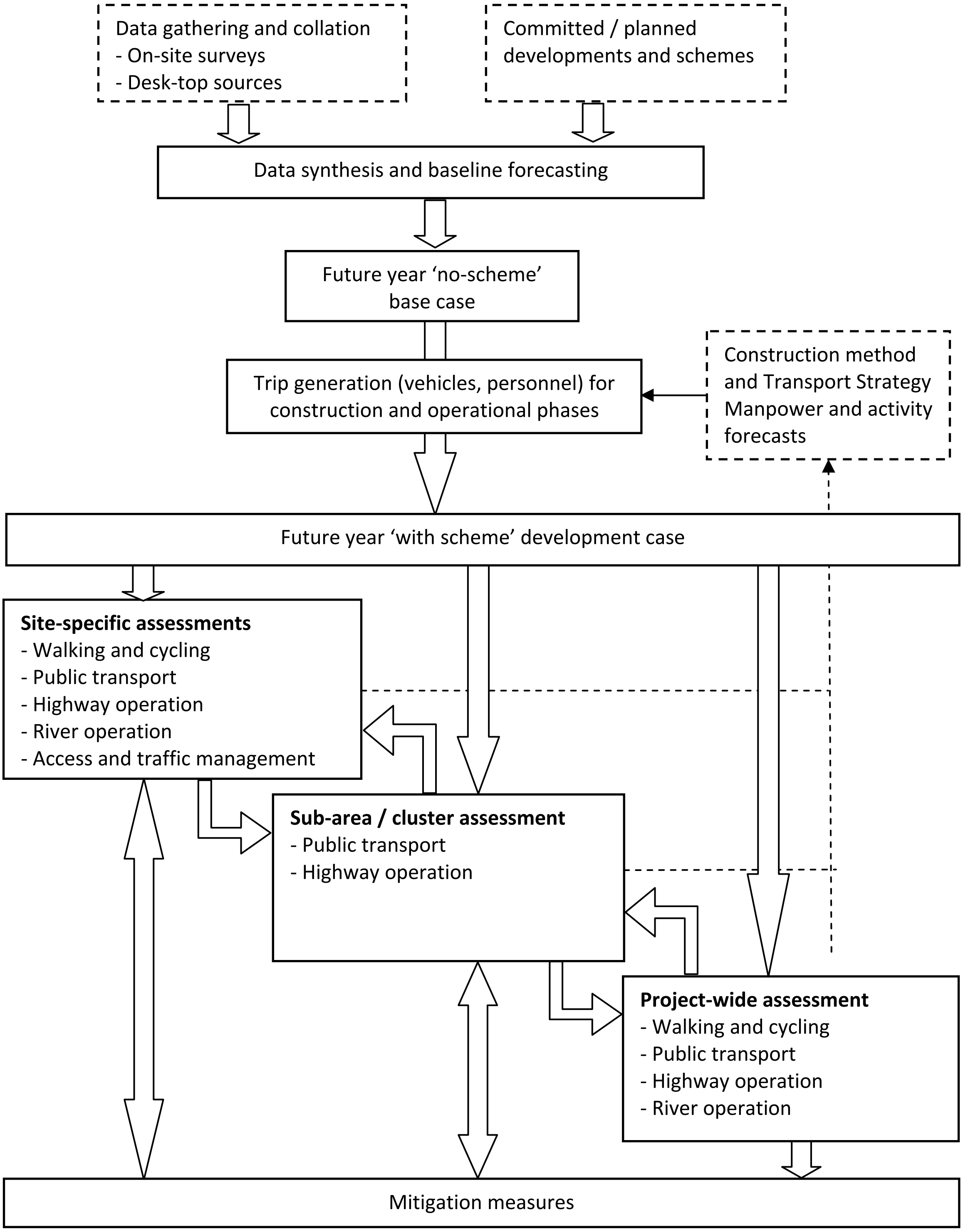
12.5.9 The assessment areas for each site are explained in Section 12 within Vol 4 to 27 of the *ES*.

Methodology

12.5.10 As set out in para. 12.5.1, the transport assessment examines the effects of the project at three levels.

12.5.11 Vol 2 Plate 12.5.1 provides a simplified flow diagram illustrating the principles of the forecasting and assessment approach. It applies to both the construction and operational phases, insofar as the operational assessment requires it. The diagram shows the site-specific, sub-area, cluster and project-wide levels of assessment and the iterative relationship between the *Transport Strategy*, assessment and the identification of mitigation measures (many of which have been embedded into the project design).

Vol 2 Plate 12.5.1 Transport – forecasting and assessment process



12.5.12 The construction proposals would influence vehicle and personnel movement demands through a combination of:

a. the construction site methodology, including the works to be undertaken at each site, which would influence the number of personnel required at each location and the likely volumes of material (and thus construction traffic) that are expected

b. the construction programme, which would influence the profile of construction activity at sites

c. the *Transport Strategy*, including the degree to which the river may be used to transport materials to and from certain sites, which would directly influence the numbers of construction vehicles associated with construction at each site.

12.5.13 The transport effects of the project have been assessed on the basis of the *Transport Strategy* which envisages:

a. excavated material from the main tunnel being exported by river at Carnwath Road Riverside, Kirtling Street and Chambers Wharf

b. excavated material from the shafts being exported by river at Putney Embankment Foreshore, Carnwath Road Riverside, Cremorne Wharf Depot, Chelsea Embankment Foreshore, Heathwall Pumping Station, Albert Embankment Foreshore, Victoria Embankment Foreshore, Blackfriars Bridge Foreshore, Chambers Wharf and King Edward Memorial Park Foreshore

c. other excavated material being exported by river at Putney Embankment Foreshore, Cremorne Wharf Depot, Chelsea Embankment Foreshore, Albert Embankment Foreshore, Victoria Embankment Foreshore, Blackfriars Bridge Foreshore, Chambers Wharf and King Edward Memorial Park Foreshore

d. cofferdam fill being imported and subsequently removed by river at Putney Embankment Foreshore, Chelsea Embankment Foreshore, Heathwall Pumping Station, Albert Embankment Foreshore, Victoria Embankment Foreshore, Blackfriars Bridge Foreshore, Chambers Wharf and King Edward Memorial Park Foreshore

e. main tunnel secondary lining aggregates being imported by river at Carnwath Road Riverside, Kirtling Street and Chambers Wharf

f. all other materials being imported and exported by road.

12.5.14 For the purposes of the assessment it has been assumed that 90% of these materials are taken by river. This allows for the possibility of periods during which the river is unavailable or material is unsuitable for river transport.

12.5.15 The assessment has been based on 10% of the daily number of construction lorry journeys occurring in the peak hours, which has been agreed with TfL as a reasonable approach. It is recognised that it may be desirable to reduce the number of construction lorry movements in peak hours and the mechanisms for addressing this would form part of the Traffic Management Plans which are required as part of the *CoCP*

(Section 5). Movements associated with construction personnel have been derived from the anticipated shift patterns and working hours at each site.

12.5.16 With regard to river transport, the assumed barge sizes at each of the construction sites where material would be transported by river (based on consultation with the PLA and site arrangements), are set out in Vol 2 Table 12.5.1 below.

Vol 2 Table 12.5.1 Transport – barge sizes

Site name	Excavated material	Imported cofferdam fill	Bulk aggregates
Putney Embankment Foreshore	350T	350T	n/a
Carnwath Road Riverside	800T	n/a	350T
Cremorne Wharf Depot	350T	n/a	n/a
Chelsea Embankment Foreshore	800T	800T	n/a
Kirtling Street	1000T	n/a	350T
Heathwall Pumping Station	350T	350T	n/a
Albert Embankment Foreshore	350T	350T	n/a
Victoria Embankment Foreshore	800T	800T	n/a
Blackfriars Bridge Foreshore	800T	800T	n/a
Chambers Wharf	1500T	1000T	350T
King Edward Memorial Park Foreshore	1000T	1000T	n/a

12.5.17 The assessment for the construction phase has considered transport issues associated with all transport modes relevant to each site. Each site-specific assessment has also taken account of any movement demands arising from other Thames Tideway Tunnel project sites that could affect transport conditions in the vicinity of the site being assessed.

12.5.18 The assessment approach has involved a combination of quantitative analysis and qualitative professional judgement to determine the likely effects and their significance in each location and is described in the following paragraphs.

Pedestrians and cyclists

12.5.19 Physical changes to pedestrian and cycle routes arising from the proposals at each construction site have been identified. The implications of those changes have been examined in relation to pedestrian and cycle journey times, safety and levels of pedestrian and cycle demand.

12.5.20 Consideration has also been given to any linkages to key pedestrian or cycle destinations that would be affected by the project, including for example, links to public transport stops and interchanges, major tourism destinations and access to the Thames Path.

Public transport

12.5.21 The assessment has examined the additional passenger demands that would be placed on public transport services (bus, rail and river) by construction personnel. Analysis has been undertaken to determine whether the expected increase in demand associated with construction workers using public transport to travel to and from sites could be accommodated on existing services, whether modifications to services would be required, or whether other measures would need to be provided to address personnel travelling to site other than by private car.

12.5.22 The geographic threshold used in the transport assessment for considering public transport services in the vicinity of each construction site reflects those thresholds specified in the TfL PTAL methodology. These typically cover walking distances of 640m and 960m from the site for bus and rail/river services respectively.

12.5.23 The PTAL methodology does not consider public transport services beyond these threshold distances in the PTAL calculation. However, this does not necessarily mean that public transport services are beyond a tolerable walking distance from a given location. The site-specific assessments consider public transport services within these threshold distances, or identify the nearest services where these are beyond the threshold distances.

12.5.24 Public transport services, particularly bus services, may also be affected by the impacts of the project on the operation of the highway network. The assessment of the highway network is discussed in paras. 12.5.27 - 12.5.43 and includes identification of whether road-based public transport services are likely to suffer additional delay as a result of the project.

12.5.25 The assessment has also considered the need for relocation or reprovision of set-down, pick-up or standing facilities for both taxis and coaches in the vicinity of construction sites.

River transport

12.5.26 At relevant sites consideration has been given to the impact of the project on the use of the river by vessel operators or leisure users. In such cases the assessment has examined whether transporting construction materials by river would lead to any effects on other river users. It also examines whether amendments to passenger piers or other means of river access would result in any significant effects for passengers and river service operators.

Highway network

12.5.27 The assessment has examined whether the construction site proposals would result in a loss of on-street car parking on a temporary or permanent basis. Where appropriate, it has identified whether and how alternative provision could be made to accommodate such displacement and the impact on parking provision and activity that would result.

12.5.28 The operation of the highway network has been examined through the derivation of a construction development case for analysis. The assessment covers the key peak and off-peak time periods set out in para. 12.4.26.

12.5.29 The project aims to minimise the number of car journeys made by workers to and from sites. At all sites, with the exception of Abbey Mills Pumping Station and Beckton Sewage Treatment Works, there would be no parking provided within the site boundary for workers. A *Draft Project Framework Travel Plan* has been prepared which addresses project-wide travel planning measures and requirements for site-specific *Travel Plans* to be developed by site contractors.

12.5.30 At many of the sites, parking in surrounding streets is already controlled and this would discourage workers from travelling by car. At some sites, however, it is recognised that parking in surrounding streets is not controlled and for those sites, the assessment considers the effects if a proportion of workers were to drive to the site. This does not detract from the measures proposed in the *Draft Project Framework Travel Plan* but ensures a reasonable assessment.

12.5.31 The anticipated mode share for worker journeys has been derived for each site individually, based on 2001 Census data for journeys to workplaces in the vicinity of each site. This approach has been agreed with TfL, as 2011 Census data was not available at the time of undertaking the assessment. Where necessary, the 2001 Census data has been adjusted to reduce the proportion of workers assumed to drive, for the reasons explained in paras. 12.5.29 and 12.5.30.

12.5.32 The highway network assessment has incorporated the anticipated construction vehicle movements together with vehicle movements associated with construction worker travel (where relevant) and has taken account of embedded measures within the design of the project.

12.5.33 The construction assessment has been addressed at both a strategic (ie, project-wide, cluster and sub-area assessments) and local (ie, site-specific) level, as each informs the other in relation to the demands placed on the highway network around each of the sites. In this way, site-specific assessments have been able to take account of any Thames Tideway Tunnel project construction traffic demands, whether arising from the site being assessed or from other Thames Tideway Tunnel sites contributing traffic to the area of the highway network around the site being assessed.

Strategic level construction assessment

12.5.34 At the strategic level, the TfL HAMs have been used to examine the changes to network operation that would result from vehicle activity or any substantial physical network changes associated with the project. This has enabled key locations and construction works which would be most likely to have the greatest network effects to be identified and further tests to be made of potential strategies for mitigation.

12.5.35 Potential highway network changes and management measures that have been developed through the design process and those from the local model analysis have been incorporated into iterations of the strategic modelling to ensure that any wider implications have been identified and addressed in the overall assessment.

12.5.36 For the highway network assessment, the aggregate average peak hour numbers of construction vehicle movements for the month in which project-wide lorry activity would be greatest (Project Year 4 of construction) have been added to the three TfL 2021 forecast year HAMs. This has produced a 'project-wide peak' scenario.

12.5.37 The assignment of construction and worker traffic has been undertaken using OmniTrans[iii] assignment software. This has enabled traffic to be correctly assigned across the London highway network based on the construction routes and material type identified for each site.

12.5.38 The project-wide highway assessment methodology is described in more detail in Section 12.8.

Local level construction assessment

12.5.39 The strategic modelling work has informed the scope of local network modelling around individual construction sites. Where local road junctions would be affected by construction traffic, the assessment has used appropriate junction modelling software as described in para. 12.4.36 to determine the effects and test potential solutions.

12.5.40 The site-specific highway network assessments have examined the months in which the average daily number of construction lorries would be greatest at each site. The average peak hour vehicle numbers for these peak periods have been added to the local construction base case models, based on the assignments using the OmniTrans software and the outputs from the HAMs described in paras. 12.5.34 to 12.5.38.

12.5.41 The use of the OmniTrans and HAMs outputs has ensured that each local junction model for the construction development case includes any construction traffic from other Thames Tideway Tunnel project sites that would pass through that junction.

12.5.42 Where traffic signal modelling was required, TfL has been consulted to ensure that relevant signal timing and operational information has been taken into account in the modelling. Traffic signal modelling has followed TfL's standard *Modelling Guidelines* (TfL, 2010)[22] and *Model Audit Processes* (TfL, 2011)[23] and has been based on developing existing local junction models already held by TfL or new models produced for this assessment, as described in para. 12.4.36.

12.5.43 The analysis of highway network operation has enabled information to be produced in relation to network and junction capacity and operation and

---

[iii] OmniTrans is a software package used for multi-modal transport network modelling and in this case has been used to produce assignments of construction traffic across the proposed network of routes to be used for the project.

thus the identification of potential changes to journey times that could arise from the project, either locally or in the wider area.

Significance criteria

12.5.44 The likely significant effects on transport have been determined with reference to the *Guidelines for Environmental Assessment* (IEMA, 2006)[24] and the *Design Manual for Roads and Bridges* (Department for Transport, various dates)[25]. The level of significance has been derived from measures of the magnitude of impact and the sensitivity of the receptors affected as described below.

Determining magnitude of impacts

12.5.45 The IEMA guidance is considered to provide the most appropriate framework for developing criteria for the assessment of transport effects arising from this project. It identifies a number of potential transport impact types for consideration in the environmental assessment as follows:

a. severance

b. driver delay

c. pedestrian delay

d. pedestrian amenity

e. fear and intimidation

f. accidents and safety

g. hazardous loads.

12.5.46 These impact types have been considered and aspects of them combined to produce five impact types for the purposes of this assessment. These are:

a. road network delay

b. pedestrian/cycle delay – which also reflects a measure of severance

c. pedestrian amenity[iv] – which principally reflects the nature of impacts on pedestrian routes, and thus incorporates indicators of fear and intimidation

d. accidents and safety – which reflects a measure of HGV traffic and pedestrian route issues

e. hazardous loads.

12.5.47 In addition, three further impact types have been developed for this assessment to ensure that impacts affecting other modes of transport and

---

[iv] It is noted that the socio-economic assessment (Section 10) also considers pedestrian amenity whereby it is defined as the effect on users relating to potential amenity effects caused by air quality, construction dust, noise, vibration (human response) and visual impacts, and the degree to which this could impair a public right of way's recreation/leisure/tourism functionality for users. This differs to the pedestrian amenity criteria used in the transport assessment whereby the impact is defined in terms of the project's potential to close pedestrian routes or footways or narrow a route below certain thresholds (see Vol 2 Table 12.5.4).

user types have been addressed. The additional impact types and the basis for their identification are:

a. vehicle parking and loading changes – based on professional judgement of the degree of inconvenience or disruption experienced by users as a consequence of changes related to the project

b. public transport patronage – based on professional judgement of the capacity of different service types and the degree to which variation in patronage could or could not be accommodated on existing services

c. river navigation and access – based on professional judgement of the degree of disruption to marine emergency services, vessel operators and leisure users of the River Thames as a consequence of the use of the river by the project.

12.5.48 These impact types have been considered in the context of the receptors which they are likely to affect, based on the categories described in paras. 12.4.38 to 12.4.42 and Vol 2 Table 12.4.3. Some impact types would affect only certain receptors, for example, pedestrian/cycle delay only affects those on foot and potentially those cycling where cyclists are using routes such as the Thames Path.

12.5.49 Other impacts, such as those related to safety and hazardous loads, may affect all receptors to a greater or lesser degree.

12.5.50 Vol 2 Table 12.5.2 shows which of the principal receptor types indicated in Vol 2 Table 12.4.3 are likely to be affected by each of the identified impact types.

Vol 2 Table 12.5.2 Transport – relationship between receptors and impact types

	Impact type							
Receptor	**Pedestrian /cycle delay**	**Pedestrian amenity**	**Road network delay**	**Vehicle parking and loading changes**	**Accidents and safety**	**Public transport patronage**	**Hazardous loads**	**River navigation and access**
Resident occupiers	✓	✓	✓	✓	✓			
Emergency services			✓		✓		✓	
Marine emergency services								✓
Pedestrians and cyclists (including sensitive pedestrian users)	✓	✓			✓			
Leisure users of the River Thames								✓
Business, education and workplace occupiers	✓	✓	✓	✓	✓			
Private vehicle users on the highway network			✓	✓	✓		✓	
Public transport users			✓			✓		
River vessel operators								✓
Public transport operators			✓			✓		
Service vehicle operators				✓				

Note: Building occupiers (residents and business, education and workplace occupiers) would also fall within the category of pedestrians, cyclists, public transport users and private vehicle users on the network and consideration is given to each of these travel modes in the assessment for occupiers who may be affected

12.5.51 The IEMA guidance makes it clear that a "...critical feature of environmental assessment is determining whether a given impact is significant." Furthermore, "…for many effects there are no simple rules or formulae which define thresholds of significance and there is, therefore, a need for quantified information whenever possible. Such judgements would include the assessment of the numbers of the people experiencing a change in environmental impact..."

12.5.52 The criteria for determining the magnitude of impacts for this assessment are presented in Vol 2 Table 12.5.3. These are based on professional judgement of the degree to which change under a particular heading is important. Whilst these criteria are presented in a quantifiable way, the consideration of the magnitude of an impact is also related to the context of the location in which the impact is identified as occurring. Thus, for instance, small changes in traffic flow may have greater impacts in locations where existing traffic flows are low than in locations where flows are already high; similarly additional delays to pedestrians or traffic may be perceived as being of lower magnitude on busier roads where delays can already be expected to be longer than in other locations.

12.5.53 Consideration has also been given to the time period over which identified impacts would occur. Impacts which would only occur over a short duration or infrequently have been reviewed using professional judgement to determine whether it would be appropriate to reduce the impact magnitudes suggested by the criteria identified in Vol 2 Table 12.5.3.

Vol 2 Table 12.5.3 Transport – impact magnitude criteria

Impact magnitude	Definition
Pedestrian/cycle delay	
High	Change in average waiting time of greater than two minutes at a crossing; or change in journey time of greater than four minutes on a route
Medium	Change in average waiting time of one to two minutes at a crossing; or change in journey time of two to four minutes on a route
Low	Change in average waiting time of 30 seconds to one minute at a crossing; or change in journey time of one to two minutes on a route
Negligible	Change in average waiting time of less than 30 seconds at a crossing; or less than one minute on a route
Pedestrian amenity	
High	Adverse: Pedestrian routes closed requiring pedestrians to make additional road crossings, or narrowed to less than 2.0m in width Beneficial: New pedestrian routes or crossings created leading to increased pedestrian space
Medium	Adverse: Pedestrian routes closed or diverted without need for additional road crossings, or narrowed to less than 2.5m but greater than 2.0m in width Beneficial: Pedestrian routes increased in width to more than 2.5m
Low	Adverse: Pedestrian routes require protection but not be diverted and at least 2.5m in width (or unchanged where existing width is less than 2.5m) Beneficial: Pedestrian routes increased in width by more than 0.5m
Negligible	Pedestrian routes or footways not affected
Road network delay	
High	Change in average delay to vehicles of more than four minutes at a junction or per km of route being assessed

Impact magnitude	Definition
Medium	Change in average delay to vehicles of two to four minutes at a junction or per km of route being assessed
Low	Change in average delay to vehicles of one to two minutes at a junction or per km of route being assessed
Negligible	Change in average delay to vehicles of less than one minute at a junction or per km of route being assessed
Vehicle parking and loading changes	
High	Adverse: permanent removal of existing parking spaces or loading bays during construction or operation; no spare capacity in the local area; no re-provision of parking or loading bays.
Medium	Adverse: permanent removal of existing parking spaces or loading bays during construction or operation; no reprovision of spaces but equivalent spare capacity in the local area OR reprovison of parking spaces more than 200m from their original location (more than 400m for coach parking)
Low	Adverse: permanent or temporary removal of existing parking spaces or loading bays during construction or operation; no reprovision of spaces but more than equivalent spare capacity in local area OR reprovision of parking spaces less than 200m from their original location (less than 400m for coach parking)
Negligible	No changes to parking or loading facilities.
Accidents and safety	
High	Adverse: Pedestrians / cyclists required to make additional road crossings; average of more than 40 two way construction HGV movements per hour; carriageway narrowed to less than 6.5m (lane widths to less than 3.25m); site access directly onto strategic road (SRN or TLRN) Beneficial: New controlled pedestrian crossings or cycle facilities provided; carriageway increased in width over existing dimensions; HGV movements associated with existing / previous site uses removed
Medium	Adverse: Pedestrians / cyclists required to cross site access and typical two-way pedestrian flows more than 240 people per hour (pph); average of between 20 and 40 two way construction HGV movements per hour; site access directly onto strategic road Beneficial: Pedestrian and/or cycle routes increased in width; site access from strategic road removed after

Impact magnitude	Definition
	construction; HGV movements associated with existing / previous site uses reduced by more than 50%
Low	Adverse: Pedestrians / cyclists required to cross site access and typical two-way pedestrian flows between 120 and 240 people per hour (pph); average of between four and 20 two way construction HGV movements per hour; site access not directly onto strategic road Beneficial: Site access removed after construction; HGV movements associated with existing / previous site uses reduced by up to 50%
Negligible	Pedestrians / cyclists required to cross site access and typical two way pedestrian flows less than 120 pph; average of less than four two way construction HGV movements per hour; site access not directly onto strategic road.
Public transport patronage (see paras. 12.5.54 and 12.5.55)	
High	Adverse: Increase in patronage of more than 15% of the capacity of a typical service, on a ‘per service’ basis Beneficial: Decrease in patronage of more than 15% of the capacity of a typical service, on a ‘per service’ basis
Medium	Adverse: Increase in patronage of between 10% and 15% of the capacity of a typical service, on a ‘per service’ basis Beneficial: Decrease in patronage of between 10% and 15% of the capacity of a typical service, on a ‘per service’ basis
Low	Adverse: Increase in patronage of between 5% and 10% of the capacity of a typical service, on a ‘per service’ basis Beneficial: Decrease in patronage of between 5% and 10% of the capacity of a typical service, on a ‘per service’ basis
Negligible	Change in patronage of less than 5% of the capacity of a typical service, on a ‘per service’ basis

Impact magnitude	Definition
Hazardous loads	
High	Adverse: Average of one or more hazardous loads per day expected Beneficial: Hazardous loads associated with previous site uses removed completely
Medium	Adverse: Average of between one hazardous load per day and one per week expected Beneficial: Post-construction site uses likely to generate less than one hazardous load per month
Low	Adverse: Average of between one hazardous load per week and one per month expected Beneficial: Post-construction situation likely to generate one hazardous load or fewer per year on average
Negligible	Less than one hazardous load per month expected
River navigation and access	
High	Adverse: More than eight river movements in each direction per day; and/or removal of operational wharves, moorings or foreshore access (slipways) without reprovision Beneficial: New wharves / moorings created
Medium	Adverse: Five to eight river movements in each direction per day; and/or removal of operational wharves, moorings or foreshore access (slipways) with reprovision more than 200m from original location Beneficial: Improved wharves / moorings provided in original location
Low	Adverse: Three to four river movements in each direction per day; and/or removal of operational wharves, moorings or foreshore access (slipways) with reprovision less than 200m from original location Beneficial: Improved access to foreshore (slipways) provided in original location
Negligible	Up to two river movements in each direction per day; and/or no change to operational wharves, moorings or foreshore access (slipways)

Notes: 1. The impact criteria for accidents and safety applies to pedestrians, cyclists and other highway users. Different elements of the criteria listed in this table are applicable to different user types.
2. The impact criteria for public transport patronage are based on the principle that increases in patronage are considered 'adverse', in the sense that increased patronage could lead to a need for additional capacity on public transport services. Within the transport assessment the impact criteria do not consider whether other benefits or disbenefits may arise (for example changes in revenue) as a result of changes in patronage.

3. The impact criteria for river navigation are based on the principle that increases in the number of movements on the river are considered 'adverse', in the sense that additional movements could increase the potential for obstruction to other river craft. This represents a simplified approach as the dynamic nature of river activity means that it is difficult to identify specifically whether individual craft using the river might experience obstruction.

4. The use of 'river movements' within the river navigation and access criteria takes account of the fact that a tug may haul one or two barges, depending on barge size, mooring and tidal conditions and therefore the number of river movements required could be lower than the number of barges required.

12.5.54 In relation to the impact magnitude criteria for public transport patronage, Vol 2 Table 12.5.4 sets out the assumed capacities of each type of public transport service and the numbers of passengers represented by the 5%, 10% and 15% thresholds indicated in Vol 2 Table 12.5.3.

Vol 2 Table 12.5.4 Transport – public transport patronage thresholds

		Threshold		
		5%	10%	15%
Service	Typical capacity	Number of passengers per service		
Bus	50	2.5	5	7.5
DLR	300	15	30	45
National Rail / London Overground	600	30	60	90
London Underground	1000	50	100	150
River passenger services	200	10	20	30

12.5.55 For this assessment typical capacities have been defined as follows:

a. Bus: an average capacity of 50 passengers per bus (typical of a single-decker bus). Where double-decker buses are operated, impacts would in practice be lower than those established using this capacity figure

b. DLR: an average capacity of 300 passengers per DLR service

c. National Rail/London Overground: an average capacity of 600 passengers per service. Train lengths vary on different services and capacities typically lie between 400 to 1,200 passengers per train. The figure of 600 passengers per service is considered appropriate given the range of services available and the likelihood that in peak hours, train lengths would tend to be longer than at off-peak times

d. London Underground: an average capacity of 1,000 passengers per service

e. River passenger services: an average capacity of 200 passengers per vessel.

Determining significance of effects

12.5.56 The significance of transport effects has been determined by combining the identified impact magnitudes with the receptors affected by those impacts (taking account of their sensitivity).

12.5.57 The determination of significance of transport effects is consistent with the generic significance matrix provided in Section 3 General EIA methodology of this volume, whereby moderate and major adverse/beneficial effects represent significant effects.

12.5.58 Vol 2 Table 12.5.5 sets out a summary of the significance criteria used to derive the transport effects at each receptor taking into account the relevant impact types (as set out in Vol 2 Table 12.5.2). This is based on professional judgement. Within Vol 4 to 27 of the *Environmental Statement* detailed matrices are presented to indicate the results of the assessment in terms of the balance of impacts on receptors and the conclusions on the significance of transport effects on each receptor.

Vol 2 Table 12.5.5 Transport – significance of effect criteria

Significance of effect at receptor	Description
Major adverse	Assessment showing majority of impacts (for impact types relevant to that receptor) to be of high adverse magnitude. Particularly affecting receptors of medium and high sensitivity.
Moderate adverse	Assessment showing majority of impacts (for impact types relevant to that receptor) to be of medium adverse magnitude. Affecting receptors of all sensitivities.
Minor adverse	Assessment showing majority of impacts (for impact types relevant to that receptor) to be of low adverse magnitude, with isolated impacts of medium adverse magnitude. Affecting receptors of all sensitivities.
Negligible	Assessment showing majority of impacts (for impact types relevant to that receptor) to be negligible, with isolated impacts of low adverse or beneficial magnitude. Affecting receptors of all sensitivities.
Minor beneficial	Assessment showing majority of impacts (for impact types relevant to that receptor) to be of low beneficial magnitude. Affecting receptors of all sensitivities
Moderate beneficial	Assessment showing majority of impacts (for impact types relevant to that receptor) to be of medium beneficial magnitude. Affecting receptors of all sensitivities
Major beneficial	Assessment showing majority of impacts (for impact types relevant to that receptor) to be of high beneficial magnitude. Particularly affecting receptors of medium and high sensitivity.

Sensitivity test of Transport Strategy

12.5.59 The construction effects assessment is based on the transport figures set out in the *Transport Strategy*. A sensitivity test of these figures is contained in Vol 3 Appendix J.

12.6 Operational effects assessment

12.6.1 This section describes the methodology for the assessment of transport effects during operation.

Assessment years

12.6.2 The assessment year for the operational phase at all sites is Year 1 of operation by which time all construction work would be complete and any permanent structures and changes to transport routes and networks would be in place. As transport activity associated with the operational phase is very low, there is no requirement to assess any other year beyond that date.

12.6.3 In addition, consideration has been given to the extent to which the operational assessment findings would be likely to vary materially from those assessed should the programme for the Thames Tideway Tunnel (and hence the 'opening year') be delayed by approximately one year.

Assessment areas

12.6.4 The assessment areas for the operational assessment are the same as for the construction assessment as set out in paras. 12.5.7 - 12.5.9 insofar as these are relevant to the effects arising from the operational phase of the project.

Methodology

12.6.5 As explained in the operational base case section (see paras. 12.4.62 and 12.4.63), transport demands in the operational phase would be minimal and unlikely to give rise to effects of any significance. Consequently quantitative analysis using strategic and local modelling has not been required to assess this phase. Instead, the operational assessment has been based on qualitative professional judgement. This has been agreed with TfL and the LHAs.

12.6.6 For the operational phase, the assessments have been undertaken at a local level (ie, site-specific) only. As transport activity associated with this phase is expected to be very low at each site, there is no requirement to address project-wide issues within the assessment.

12.6.7 The transport demands created by the development in the operational phase at the site-specific level would be limited to occasional maintenance visits to each site every three to six months, and the use of larger cranes and associated support vehicles required for access to the shafts and tunnel every ten years.

12.6.8 The operational effects have been considered in the context of the range of receptors present in each location. Typically however, the assessment of the operational phase has been limited to the effects on highway users resulting from the need for maintenance vehicles to access the site from the highway network. This has covered road network delay and vehicle parking changes as the impact types. In certain locations, effects on pedestrians, public transport operators and passengers, river users and river vessel operators have also been considered.

Significance criteria

12.6.9 The magnitude and significance criteria used for the assessment of operational effects are the same as those identified in Section 12.5, insofar as the criteria are relevant to the anticipated activities and effects arising from the operational phase of the project.

12.7 Cumulative effects assessment

12.7.1 The general approach to assessing cumulative effects is described in Section 3 General EIA methodology. The specific approach for transport is described below. The assessment years considered for the cumulative effects assessment remain as defined in Sections 12.5 and 12.6 above.

12.7.2 The TfL HAMs have been developed using GLA employment and population forecasts, which are based on the employment and housing projections set out in the *London Plan 2011* (GLA, 2011)[26]. As a result the assessment inherently takes into account a level of future growth and development across London.

12.7.3 Where it has been considered that the HAMs would not adequately take account of other developments under construction within the immediate area around each of the project construction sites (as set out in the Development Schedules detailing other developments in the vicinity of each site), the changes likely to arise from these developments have been incorporated into the site-specific assessments and models in the vicinity of the site in question, as explained in para. 12.4.59.

12.7.4 This approach has been applied to both the construction and operational cumulative effects assessments.

12.8 Project-wide effects assessment

12.8.1 The general approach to assessing the likely significant effects, including project-wide effects, is described in Section 3. The specific approach for assessing project-wide transport effects is described below.

12.8.2 Project-wide effects on transport would arise from the aggregation of construction-related barges travelling on the River Thames, the aggregation of construction related traffic travelling on the strategic highway network across London and potentially from the combined volume of construction workers using public and private transport to travel to and from the construction sites.

12.8.3 Project-wide assessment has not been required for the operational phase of the project, as transport activity would be very low and would be associated with local activities at each site, rather than present any significant activity on the London highway network as a whole.

Assessment years

12.8.4 The project-wide assessment examines the years in which project-wide number of barges and number of construction lorry movements would be greatest.

12.8.5 For construction barge activity associated with the project, the assessment year is Project Year 2 of construction. The assessment year for the highway network is Project Year 4 of construction, as this is the year in which the total number of construction lorries generated by project sites would be greatest. Project Year 4 of construction has also been used as the assessment year for considering the public transport networks, although this is considered less sensitive as worker numbers would not be subject to the same degree of variation as construction traffic.

12.8.6 The highway network assessments for ‘cluster’ peaks of activity related to the sites in the western, central and eastern sections of the project have also been assessed using each of the three HAMs (WeLHAM, CLoHAM and ELHAM respectively). The sites within each cluster have been defined by determining the HAM simulation area within which each site is located. To determine relevant assessment years, the peak months of aggregated construction traffic activity occurring at all of the sites in each cluster have been identified. For the central and eastern clusters, these peaks would occur in Project Year 4 of construction and for the western cluster the peak would occur in Project Year 2 of construction.

12.8.7 The sub area assessment for the Blackfriars Bridge Foreshore and Victoria Embankment Foreshore sites has been undertaken using the peak levels of traffic associated with these sites. Project Year 3 has been selected as this represents the highest level of construction traffic activity at the Blackfriars Bridge Foreshore site. Peak construction activity at the Victoria Embankment Foreshore site would occur in Project Year 2; however, the Blackfriars Bridge Foreshore site would generate a greater number of vehicle movements than the Victoria Embankment Foreshore site in the peak months of activity at each site and Project Year 3 thus represents a higher total number of construction vehicle movements generated by these two sites. In addition, the Blackfriars Bridge Foreshore site is the location at which the impacts arising from construction traffic combined with physical changes to the highway are expected to be greatest.

Assessment areas

12.8.8 The assessment area for the project-wide assessment of effects on river usage and navigation comprises the River Thames between the Hammersmith Pumping Station and Beckton Sewage Treatment Works sites.

12.8.9 The assessment area for the project-wide assessment of the highway network effectively reflects the coverage of the three TfL HAMs, which encompasses the majority of the road network within west, central and east London as far as the Greater London boundary. Where the strategic modelling has identified that changes in traffic flows would occur on parts of the highway network within these three models, further analysis has been undertaken to examine the changes and identify the likely impacts and effects.

12.8.10 Consideration has also been given to the effects that might occur in a sub-area of central London in the vicinity of the Victoria Embankment

Foreshore and Blackfriars Bridge Foreshore sites. This arises from the anticipated nature of the traffic management arrangements during construction, which could give rise to route diversions for traffic in the surrounding area.

12.8.11 The extent of this sub-area has been informed by the strategic modelling work using the TfL HAMs. The assessment area is from the junction of Victoria Embankment (A3211) with Westminster Bridge (A302) to the junction of Blackfriars Underpass (A3211) with Puddledock, including the junction of Blackfriars Bridge (A201) with Queen Victoria Street and New Bridge Street (A201).

12.8.12 For the project-wide assessment of effects on public transport, changes to public transport services in terms of patronage have been considered in the context of the wide bus, rail and river networks across London.

Methodology

12.8.13 The methodology for the project-wide assessment follows the general methodology described in Section 12.5.

12.8.14 The project-wide assessment of the effects of construction barge movements on the River Thames has been based on the aggregated totals of barge movements at different points along the length of the river, in order to take account of the fact that the number of barge movements would be lower further upstream.

12.8.15 The strategic component of the methodology for assessing highway network effects, described in paras. 12.5.27 to 12.5.43, has been used for the project-wide effects assessment. This includes the use of the TfL HAMs. Results are reported in Vol 3 at three levels:

a. Project-wide assessment - effects of the project across the entire strategic transport network.

b. Cluster assessments – effects of the project in the western, central and eastern sections.

c. Sub-area assessment – effects in a sub-area of central London around the Victoria Embankment Foreshore and Blackfriars Bridge Foreshore sites.

12.8.16 For the assessment of project-wide effects on the public transport network, the findings of the individual site-specific assessments have been used to identify whether any wider effects are likely.

Significance criteria

12.8.17 The project-wide assessment deals with effects at this level on river usage and navigation, public transport and the highway network.

River navigation and access

12.8.18 For river navigation issues, the project-wide assessment has identified the number of barges required at each site along the length of the river in the assessment year. This also allows the number of river transit movements to be identified, taking account of the potential for smaller barges to be hauled in pairs by tugs.

12.8.19 The assessment has examined how the number of barges (and thus transit movements) would change along the length of the river. By comparing these findings with the impact magnitude criteria related to river navigation (shown in Vol 2 Table 12.5.3), it identifies the locations at which the number of river transit movements would pass from one impact magnitude threshold to another. This means that the significance of effects on river navigation varies along the length of the river.

Highway network

12.8.20 In assessing the project-wide effects on the highway network, the impact criteria set out in Vol 2 Table 12.5.3 have been considered. However, there are some variations in the way in which those criteria have been used to reach conclusions on project-wide effects.

12.8.21 In considering road network delay, the summary statistics from the HAMs have been used to identify the overall degree of change to delay on the network as a whole (in each of the three modelled areas). To support this, the model outputs have been examined to identify locations where changes in journey times would fall within the thresholds set out in Vol 2 Table 12.5.3.

12.8.22 Locations where impacts would be defined as 'low' or greater based on those thresholds have been reported in Vol 3. The changes in these locations, and the number of them relative to the total number of links and junctions in each model, have then been considered alongside the overall summary statistics in order to identify the level of impact related to road network delay.

12.8.23 The criteria set out in Vol 2 Table 12.5.3 for accidents and safety are relevant at a site-specific level but are less well-suited to the consideration of whether there would be a change in accident risk at a project-wide level. For the project-wide assessment, the number of additional lorry kilometres associated with Thames Tideway Tunnel project construction traffic has been compared with London-wide accident rates provided by published statistics and by TfL. A professional judgement has then been made on the impact magnitude of the number of additional accidents implied by this approach, against the background of the overall number of accidents that occur each year on London's road network.

12.8.24 For hazardous loads, it is not appropriate to aggregate the number of hazardous loads from all project sites and compare this with the criteria in Vol 2 Table 12.5.3, as these loads would be dispersed across the London network. For the project-wide assessment of the impacts related to hazardous loads, the impacts reported in Vol 4 to 27 for each of the sites have been reviewed to inform an overall conclusion, based on professional judgement, about the impacts of these loads at a project-wide level.

Public transport

12.8.25 The assessment of project-wide effects on public transport has been based on the total number of journeys on bus, rail and river services that would be generated by the project.

12.8.26 These figures have been considered against the typical capacities of vehicles and trains, as set out in Vol 2 Table 12.5.4 and para. 12.5.55. This allows the number of journeys to be equated to an equivalent number of vehicles or trains. However, as these journeys would be spread across the public transport network in London, this provides a contextual comparison only.

12.8.27 The determination of the project-wide impact magnitudes, and thus significance, on the public transport network has therefore been based on considering the level of significance identified at each of the individual project sites. Qualitative judgement informed by the contextual comparison described in para. 12.8.26 has then been made to determine the likely effects.

Project-wide cumulative effects

Construction

12.8.28 Section 12.7 describes the approach to assessing cumulative effects as part of the construction and operational effects assessment at each of the individual sites. It explains that the TfL 2021 forecast year HAMs already include allowances for population and employment growth, based on the projections in the *London Plan 2011* (GLA, 2011)[27], and that the strategic modelling work is therefore inherently cumulative.

Operation

12.8.29 Project-wide assessment has not been required for the operational phase of the project, as transport activity would be very low and would be associated with local activities at each site, rather than present any significant activity on the London highway network as a whole.

12.9 Assumptions and limitations

12.9.1 This section details general assumptions and limitations associated with the transport assessment. Site-specific assumptions and limitations are detailed in Vol 4 to 27 (Section 12).

Assumptions

12.9.2 Section 12.4 and particularly para. 12.4.45 explains that the construction and operational base cases for the highway network assessment have been based on the TfL 2021 forecast year HAMs, irrespective of the assessment year for the construction and operational effects assessments. For the reasons indicated in para. 12.4.46, this has been considered to be robust and appropriate and has been agreed with TfL.

12.9.3 The local junction modelling analysis for the construction base and development cases has incorporated traffic signal timing optimisation as a tool within the analysis. This reflects the expectation that TfL, given its statutory role to manage the highway network most efficiently, would be implementing traffic signal timing changes on a continuous basis to respond to changing demand and ensure effective network operation.

12.9.4 The assessment is based on the proposed *Transport Strategy*, which envisages transporting certain construction materials by river at 11 of the project sites, with the remainder of materials associated with those sites being transported by road. The specific proportions of materials assumed to be transported by river are outlined in paras. 12.5.13 and 12.5.14, along with assumed barge sizes in para 12.5.16. At the remaining 13 project sites, all construction materials would be transported by road.

12.9.5 Additionally, the assessment has assumed that a maximum of 10% of the daily construction vehicle movements associated with the transportation of materials would take place in each of the peak hours, as described in para. 12.5.15, and the assessment for the construction phase assumes the implementation of all measures identified in the *CoCP Part A* and *Part B's* (Section 5).

Limitations

12.9.6 The principal limitations relevant to the assessment are:

a. Given the scale of the London highway network it has been impractical to undertake a completely comprehensive data collection exercise on the whole network using field surveys. The assessment therefore relies in part upon the information available from the TfL HAMs for the site-specific and project-wide assessments. This approach has been agreed with TfL.

b. The assessment is based on the operation of the transport networks under normal undisrupted day-to-day conditions in the time periods being assessed.

c. The anticipated mode share for worker journeys has been derived for each site individually, based on 2001 Census data for journeys to workplaces in the vicinity of each site. This is because as 2011 Census data was not available at the time of undertaking the assessment. This approach has been agreed with TfL.

12.9.7 Despite these limitations, the assessment is considered robust as it reflects typical conditions on the highway network using agreed analytical models. The base case is itself robust for the reasons indicated in para. 12.4.46 and the assessment has considered the months in which barge and construction lorry movements would be greatest at both site-specific and project-wide levels.

12.10 Mitigation

Construction

12.10.1 The Thames Tideway Tunnel project has been designed to minimise environmental effects and therefore the construction design/methods take account of transport considerations including:

a. the need to minimise changes to pedestrian and cycle routes during construction whilst also ensuring that appropriate separation is maintained between these users and construction traffic for safety reasons

b. the need to ensure that any long-term traffic management solutions required maintain minimum lane widths and two-way traffic flow where possible and to provide appropriate diversionary signage

c. changes required to the highway network to facilitate the movement of larger construction vehicles without encroaching onto footways, with reinstatement wherever possible in the operational phase

d. changes required to car, coach, cycle or motorcycle parking provision as a result of construction activity and the need to provide alternative locations and capacity where possible

e. a *Draft Project Framework Travel Plan* including site-specific requirements and guidelines to reduce the number of construction workers travelling by private car and encourage the use of other transport modes.

12.10.2 Where such measures form part of the project, they are identified in Vol 1 (for the tunnel itself) and Section 3 of Vol 4 to 27 (for each site) and have been considered as embedded measures within the assessment.

12.10.3 Where the assessment indicates significant effects having taken account of embedded measures, mitigation has been identified as appropriate.

12.10.4 In some cases mitigation of significant effects has not been possible and the embedded measures remain the most appropriate measures for the location in question.

12.10.5 In some locations where minor adverse, and therefore not significant, effects have been identified, consideration has also been given to whether mitigation measures would be appropriate, for instance to ensure pedestrian or cyclist safety, even if this does not always lower the residual effects with the mitigation in place.

Operation

12.10.6 The Thames Tideway Tunnel project has been designed to minimise environmental effects and therefore the design takes account of transport considerations including the need to provide access for regular maintenance activities every three to six months and more significant maintenance approximately every ten years. Where such measures form part of the project, they are identified in Vol 1 (for the tunnel) and Section 3 of Vol 4 to 27 (for each site) and have been considered as embedded environmental design within the assessment.

12.11 Residual effects assessment

12.11.1 Where mitigation measures are proposed, residual effects are assessed by reviewing the assessment for the relevant transport mode on a quantitative or qualitative basis, as appropriate, and determining whether the outcomes would be different with the mitigation measures taken into account.

12.11.2 Where no mitigation measures are proposed, the residual effects remain as identified through the relevant assessment (construction, operation or project-wide).

References

[1] Transport for London, *Transport Assessment Best Practice Guidance* (April 2010).

[2] Institute of Environmental Management and Assessment (IEMA), *Guidelines for Environmental Assessment* (January 1993, last updated 2006).

[3] Department for Transport, *Design Manual for Roads and Bridges* (various dates), Volume 11 Environmental Assessment.

[4] Transport for London, *Traffic Modelling Guidelines* (September 2010).

[5] Transport for London, *Model Auditing Process (MAP): Traffic Schemes in London Urban Networks Version 3.0* (March 2011).

[6] Transport for London, *Accessible Bus Stop Design Guidance*, BP1/06 (January 2006).

[7] Transport for London, *London Cycling Design Standards* (undated), http://www.tfl.gov.uk/businessandpartners/publications/2766.aspx (site last accessed December 2012).

[8] Transport for London, *Walking Good Practice Version 3.0* (June 2010).

[9] Transport for London, *Travel Planning for New Development in London*, (March 2011), http://www.lscp.org.uk/newwaytoplan/travelplan_guidance.html#sh1 (site last accessed December 2012).

[10] Transport for London, *Assessment Tool for Travel plan Building Testing and Evaluation (ATTrBuTE)*, http://www.attrbute.org.uk (site last accessed December 2012).

[11] Department for Environment, Food and Rural Affairs, *National Policy Statement for Waste Water* (March 2012)

[12] Fruin, JJ. *Pedestrian Planning and Design*, Metropolitan Associated of Urban Designers and Environmental Planners (1971).

[13] Transport for London, 2010. See citation above.

[14] TfL Planning Information Database, http://www.webptals.org.uk/ (site last accessed December 2012).

[15] Transport for London website, http://www.tfl.gov.uk (site last accessed December 2012).

[16] Sustrans website, http://www.sustrans.org.uk (site last accessed December 2012).

[17] Walk London website, http://www.walklondon.org.uk (site last accessed December 2012).

[18] Greater London Authority, *The London Plan – Spatial Development Strategy for London* (July 2011).

[19] Transport for London, 2010. See citation above.

[20] Transport for London, 2011. See citation above.

[21] Institute of Environmental Management and Assessment, 2006. See citation above.

[22] Transport for London, 2010. See citation above.

[23] Transport for London, 2011. See citation above.

[24] Institute of Environmental Management and Assessment, 2006. See citation above.

[25] Department for Transport, various dates. See citation above.

[26] Greater London Authority, 2011. See citation above.

[27] Greater London Authority, 2011. See citation above.

This page is intentionally blank

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.02**

Volume 2: Environmental assessment methodology

Section 13: Water resources - groundwater

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

Hard copy available in

Box **16** Folder **A**
January 2013

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

This page is intentionally blank

Thames Tideway Tunnel

Environmental Statement

Volume 2: Environmental assessment methodology

Section 13: Water resources – groundwater

List of contents

Page number

List of plates

Page number

List of tables

Page number

13 Water resources – groundwater

13.1 Introduction

13.1.1 This section sets out the methodology for assessing the likely significant effects of the Thames Tideway Tunnel project on groundwater[i].

13.1.2 The methodology outlined in this section has been applied to all sites, unless otherwise indicated in the site assessment volumes. The methodology for assessing project-wide effects is also described.

13.1.3 The need for an assessment of groundwater effects results from the potential for the project to affect two aquifers[ii], the upper and lower aquifer. The upper aquifer comprises the Alluvium and River Terrace Deposits/ gravels, and the lower aquifer comprises the lower part of the Lambeth Group (Upnor Formation), Thanet Sands and the Chalk.

13.1.4 The likely significant effects on groundwater resources could be both quantity and quality related. For example, dewatering[iii] may affect the protected rights of groundwater users; whilst site construction activities may create a vertical pathway for pollution from contaminated land or groundwater to affect aquifers or connect aquifers/sub-aquifers with different quality groundwater via shafts. There may also be potential impacts on groundwater along the route of the main tunnel and connection tunnels (between shafts and the main tunnel and connection tunnels) which may create a lateral pathway connecting poor quality groundwater resources with high quality ones.

13.1.5 There is some overlap between the assessment of groundwater effects and the assessment of land quality effects where the presence of contaminated land may have an effect on groundwater. The land quality assessment (Section 8 Volumes 4 to 27) identifies soil contamination and the measures to be put in place to prevent pollution of groundwater. The land quality assessment also assesses the likely significant effects associated with groundwater contamination on human health. The groundwater assessment includes consideration of existing groundwater pollution and the measures required to ensure that the project does not exacerbate any current pollution or introduce pollution to groundwater bodies.

13.1.6 The groundwater assessment also overlaps with the flood risk assessment (Section 15 Vol 4 to 27). The groundwater assessment identifies and

---

[i] Groundwater - all water below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil.

[ii] Aquifer - A permeable stratum, either through intergranular and/or fracture permeability and which is capable of supporting water supply and/or river base flow. There are two types of aquifers, principal and secondary aquifer depending on whether these are regionally or locally important.

[iii] Dewatering - method of controlling groundwater levels by the removal of water from a source (surface or groundwater).

assesses construction and operation effects on water levels in the upper aquifer which is used as part of the assessment of groundwater flood risk.

13.1.7 An assessment of how the Thames Tideway Tunnel project would affect the objectives of the Water Framework Directive has been undertaken and can be found in Vol 3 Appendix L.2. The Greenwich Chalk and Tertiaries are the groundwater body which could be affected. The Greenwich Chalk and Tertiaries correspond to the lower aquifer in the groundwater assessment. The likely significant effect of the Thames Tideway Tunnel project on the lower aquifer has been assessed in the project wide assessment and for all those sites where the lower aquifer could be impacted by the development.

13.1.8 The topic specific methodology presented in this section builds upon the general assessment methodology summarised in Section 3 General EIA methodology and develops this to take account of the range of likely significant environmental effects on groundwater arising from the construction and operation of the project.

13.2 Engagement

13.2.1 The general approach adopted regarding engagement is summarised in Section 2 EIA process, consultation and engagement.

13.2.2 A series of Technical Working Group (TWG) meetings have been held on with the Environment Agency (EA). The TWG were attended by experts from both the groundwater resources and groundwater quality sections of the EA. Regular discussions on the assessment methodology have been held at these meetings which have enabled tailored methodologies to be developed. In addition, scoping opinions (see Vol 2 Appendix A.1, A.2 and K.1) and phase two consultation comments from the EA have also been incorporated into the methodologies described in this volume although only project-wide and site-specific comments were received. The IPC provided comments on the *Scoping Report* (see Vol 2 Appendix A.3) relating to a variety of issues, such as dewatering methods, which are reflected in the embedded measures and *Code of Construction Practice (CoCP)*. The *CoCP* is provided in Vol 1 Appendix A. It contains general requirements (Part A), and site specific requirements (Part B). These have been addressed within this *Environmental Statement*.

13.2.3 The phase two consultation responses comments mainly relate to project-wide effects and are addressed in Volume 3 Project-wide effects assessment. The TWG meetings have also addressed all the subsequent issues raised by the EA at these meetings. Any site specific comments are addressed in the engagement section of the site assessments (Vol 4-27 Section 13.3).

13.2.4 The relevant London local authorities have been approached for information on unlicensed abstractions and Strategic Flood Risk Assessments (SFRA) for their local authority areas.

13.2.5 For those abstraction licences considered at possible risk, the individual holders have been approached to obtain specific details about their sources. Individual licence holders were initially contacted by letter in

2011 (see Vol 2 Appendix K.5). Further correspondence with the individual licence holders was undertaken during targeted consultation in summer 2012.

13.3 Legislation and guidance

13.3.1 In assessing the likely significant effects on groundwater resources, the following legislation and guidance have been taken into account:

a. *The Water Resources Act* (1991)[1] – legislation which covers both abstraction and effluent discharge.

b. *The Water Act* (2003)[2] – relates to provision for consenting of dewatering abstraction.

c. *The Water Framework Directive* (WFD) (EC Directive 2000/60/E)[3] and amendments – setting environmental objectives for groundwater quality and quantity.

d. *WFD Groundwater Daughter Directive* (EC Directive 2006/118/EC) (Defra, 2006)[4] – protection of groundwater quality.

e. *Groundwater Regulations 2009*[5] – preventing discharges of hazardous and non-hazardous substances to the environment.

f. *EA Groundwater Protection: Principles and Practice* (GP3) 2011[6].

g. *Environmental Permitting Regulations 2010*[7].

13.3.2 The legislation referred to above has informed the methodology and has been used in defining the receptor value/sensitivity criteria.

13.3.3 Vol 2 Table 13.3.1 presents the requirements within the NPS relevant to groundwater resources and explains how the requirements have been addressed within the *Environmental Statement*. The table also gives the location of the relevant material.

Vol 2 Table 13.3.1 Groundwater – requirements of the NPS and how they have been addressed

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
Section 4.2.		
The applicant should in particular describe: The existing quality of water affected by the proposed project and impacts of the proposed project on water quality	The ES describes the existing water quality and assesses the likely significant effects at a project wide level and also on a site by site basis. The Groundwater environmental monitoring strategy includes a description of the project wide monitoring which has been undertaken as well as the proposed groundwater quality monitoring.	The groundwater project wide assessment can be found in Volume 3 Section 10 of the ES. The Groundwater environmental monitoring strategy can be found in Volume 3 Appendix K.1. Full details of the individual sites and supporting appendices are contained in Vol 4 to

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
	The seepage of sewage from the tunnel/shafts and into the tunnel/ shafts have been estimated for both upper and lower aquifers in order to consider the potential effects on groundwater resources.	27 Section 13 and Appendix K. Seepages from and into the tunnel and shafts are contained in Vol 2 Appendix K.3.
The applicant should in particular describe: Existing water resources affected by the proposed project and the impacts of the proposed project on water resources noting any relevant existing abstraction rates, proposed new abstraction rates and proposed changes to abstraction rates	The ES describes the groundwater resources affected by the proposed development. The Groundwater environmental monitoring strategy includes monitoring results for groundwater resources as well as the proposed monitoring strategy. The impacts of the proposed project are described at a project wide level and at a site level. The quantification of impacts from dewatering (on existing abstractions and the lower aquifer as a resource), uses the results from groundwater modelling to predict the impacts on individual abstraction licences, both public and private water supply sources.	Full details of the Project wide assessment is contained in Vol 3 Section 10. The Groundwater environmental monitoring strategy can be found in Vol 3 Appendix K.1. Supporting modelling of dewatering is contained in Vol 3 Appendix K.2. The site assessments can be found in Vol 4 – 27 with supporting data included in Appendix K.
The applicant should in particular describe: Existing physical characteristics of the water environment (including quantity and dynamics of flow) affected by the proposed project and any physical modifications to these characteristics	The physical impacts of sub-surface construction activities on the upper aquifer have been assessed using a generic model for all sites and considering the obstruction effects caused by the different sizes of construction sites. The assessment of physical impacts on the lower aquifer has been done qualitatively for those sites where the lower aquifer would be affected. The likely significant effects of physical obstruction are described for both the construction and operation in the site specific volumes.	The methodology for assessing physical obstruction effects on the upper aquifer is contained in Vol 2 Appendix K.2. The assessment of likely significant effects on the upper and lower aquifer during both construction and operation are included in the site assessments Vol 4 – 27 Section 13.5 and 13.6.
The applicant should in particular	The impacts on groundwater bodies defined by WFD have been	The WFD assessment is included in Vol 3

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
describe: Any impacts on the proposed project on water bodies or protected area under the WFD and source protection zones around potable abstractions.	assessed as part of a wider WFD assessment. The Greenwich Chalk and Tertiaries are the groundwater body identified for the Thames River Basin Management Plan. The Greenwich Chalk and Tertiaries correspond to the lower aquifer. The likely significant effect of the Thames Tideway Tunnel project on the lower aquifer has been assessed in the project wide assessment and all site assessments where the lower aquifer would be impacted by the development. Source protection zones have been identified and the impacts on these described as part of the site assessments as well as the project wide assessment.	Appendix L.2. Site assessments are included in Vol 4 - 27 Section 13. The project wide assessment is included in Vol 3 Section 10.
The applicant should in particular describe: Any cumulative effects	Cumulative effects have been identified and screened against potential groundwater impacts. Those developments which could contribute to cumulative effects are identified at both the project wide and site specific level. They have then been assessed qualitatively.	The methodology for screening cumulative developments is included in Vol 2 Appendix K.4. Those projects identified cumulative assessment are described in Section 13.3 while the assessment of cumulative effects can be found in Section 13.7 of each volume (including project-wide).
The decision maker should give impacts on the water environment more weight where a project would have adverse effects on the achievement of the environmental objectives under the WFD.	The environmental objectives of the WFD are specifically addressed through a WFD assessment.	The WFD assessment is included in Vol 3 Appendix L.3.

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
The decision maker should be satisfied that the proposal has regard to the River Basin Management Plan and meets the requirements of the WFD and its daughter directives, including those on priority substances and groundwater. The decision maker should also consider the interactions of the proposed project with other plans such as Water Resource Management Plans.	The WFD assessment sets out the assessment of the Thames Tideway Tunnel project. The WFD priority substance daughter directive and the WFD groundwater daughter directive are considered through the assessment of likely significant effects on water quality within the groundwater are assessed. This includes the reporting of effects against Environmental quality standards (EQS) in the individual site assessments. The assessment has taken full consideration of existing public water supply abstraction sources within the Water Resource Management Plan. Impacts at these sources have been limited through design measures (such as internal dewatering) and are reported in the project wide and site specific assessments.	The WFD assessment is included in Vol 3 Appendix L.2. The Groundwater environmental monitoring strategy can be found in Vol 3 Appendix K.1. The project wide assessment is included in Vol 3 Section 10. Site assessments are included in Vol 4 - 27 Section 13.
The decision maker should consider proposals to mitigate adverse effects on the water environment put forward by the applicant are acceptable.	Mitigation is included wherever significant effects have been identified. For groundwater this is only during the construction phase. The project wide assessment and the site assessments contain a section on the proposed mitigation.	Project wide mitigation for the construction phase is included in Vol 3 Section 10.8.

13.4 Baseline data collection

13.4.1 This section describes the baseline data collected for the assessment of groundwater effects. This includes data collected through desk based studies and consultation with stakeholders, as well as data obtained from field surveys and site investigations.

13.4.2 The ground investigation undertaken for the Thames Tideway Tunnel project has involved drilling boreholes both on the banks and within the main river channel for the purposes of understanding the geology and hydrogeology within the assessment area, from Acton Storm Tanks in the west to Beckton Sewage Treatment Works in the east and to Greenwich Pumping Station in the southeast.

13.4.3 The EA has provided a broad range of data including groundwater levels, groundwater quality, groundwater abstraction licence details and hydraulic property information for the assessment area (as defined in Section 13.4).

13.4.4 The EA has also provided information on aquifer parameters, layer thicknesses and the location of faults from its London basin groundwater model (EA and ESI, 2010)[8] (within the assessment area).

13.4.5 SFRAs have been obtained from the relevant London local authorities in order to gain information about groundwater flood risk.

Desk based baseline data

13.4.6 Vol 2 Table 13.4.1 outlines the baseline data set that has been used for both the site-specific assessments (Vol 4 to 27) and project-wide assessment (Vol 3) and its sources.

Vol 2 Table 13.4.1 Groundwater – desk based baseline data sources

Source	Data
BGS	British Geological Survey (BGS) 1:50,000 scale digital geological data
London local authorities	Unlicensed groundwater abstraction boreholes and their details
	SFRA
EA	Licensed and unlicensed groundwater abstraction boreholes, their ownership and purpose
	Designated source protection zones
	Groundwater level records for EA observation boreholes
	Groundwater quality results for EA observation boreholes
	Ground Source Heat Pump (GSHP) schemes and their details
	Regional Groundwater Levels in Chalk from 2000 to 2011
	London Basin Aquifer Conceptual Model (60121R1, June 2010)
	London Basin Groundwater Model
Thames Tideway Tunnel project	Land quality data (see Vol 4 – 27 Appendix F.1)
Individual licence holders	Response of licence holders to enquiries (Vol 2 Appendix K.5)

Field survey baseline data

13.4.7 Ground investigations undertaken by Thames Tideway Tunnel project in 2009 and 2012 along the tunnel route have facilitated the collection of hydrological data. The majority of exploratory boreholes are used as observation boreholes for long term monitoring purposes once their original purpose has been fulfilled.

13.4.8 The aim of the ongoing groundwater monitoring is to provide comprehensive details of conditions across all sites and along the tunnel alignment route, including strata and land quality conditions**.**

13.4.9 Groundwater level monitoring commenced in 2010 for many of the ground investigation boreholes. Most of the boreholes are dipped (sampled) monthly and also have data loggers installed. Groundwater monitoring would continue at all available boreholes until the commencement of construction works.

13.4.10 Ground water quality sampling commenced in August 2011 (at seven lower aquifer sites and five upper aquifer sites), initially using a standard test of up to 80 determinands. A second round of sampling was undertaken in September and October 2011, using a longer list of determinands (approximately 300 determinands), as agreed with the EA. Those determinands found to be present were then added to the standard test determinands; along with any additional determinands which had been found through the monitoring of Lee Tunnel boreholes or at EA water supply/abstraction boreholes. Further sampling rounds have been completed in November 2011, January 2012 and May 2012.

13.4.11 Each time a new borehole is commissioned for monitoring it has been sampled against the long list of determinands and any previously unrecorded determinands added to the standard test.

As the monitoring of groundwater quality and quantity would continue through the construction phase into the operation phase of the project a separate *Groundwater environmental monitoring strategy* (see Vol 3 Appendix H.1) has been developed which would remain a live document through the construction of the Thames Tideway Tunnel project. This also outlines the monitoring that would be undertaken during the construction and operation of the Thames Tideway Tunnel project.

Receptor identification and sensitivity

13.4.12 The sensitivity or value of a groundwater body (the receptor) is based on three aspects: quality, quantity and use of the groundwater resource. For example, a groundwater body may be valuable as a source of drinking water or as a support to a groundwater dependent ecosystem. For this reason, in addition to groundwater quality and quantity, the use of the receptor forms an important factor in defining its sensitivity. This differs for each abstraction end use or dependency. There is therefore an element of professional judgement applied in the assignment of receptor value/sensitivity. Where professional judgement has been applied it is explained in the individual site assessments.

13.4.13 Vol 2 Table 13.4.2 shows the criteria used to classify groundwater receptors value/sensitivity based on the quantity of the resource; whilst Vol 2 Table 13.4.3 defines the value/sensitivity criteria with regards to groundwater quality.

13.4.14 The factors taken into account in defining the value/sensitivity of receptors in respect of quantity include their classification according to the EA's principal aquifer[iv]/secondary aquifer[v]/unproductive strata[vi] definitions. For example, the Chalk aquifer is defined as a principal aquifer and has been given high value in the assessments. The upper aquifer is defined as being of medium value for groundwater quantity.

13.4.15 The presence of protected rights/abstractions is also considered in determining groundwater quantity receptor value. Public water supply abstractions are the largest and most sensitive sources within the central London area and have been allocated a high value. Similarly private water supplies have also been defined as being of high value. High value has also been given to licensed ground source heat pump (GSHP) schemes from the Chalk, due to their size, absence of alternatives and protected rights status.

13.4.16 Sources licensed for agricultural or industrial uses have been defined as medium importance, although consideration has been given to the size of the abstraction (and its ability to be replaced/substituted).

13.4.17 The low value category has been allocated to smaller abstractions (unlicensed sources) and unproductive strata. In all cases, a degree of professional judgement has been required to assess the value/sensitivity of abstraction sources.

13.4.18 Under certain circumstances, the receptor importance may be different for quantity and quality. For example, there may be water resources available but because of their quality, their use is limited to certain purposes. In such a case, the receptor value may be lower for quality considerations than it is for quantity considerations. In this case, a different receptor value/sensitivity is used for assessing quality and quantity related impacts. Where this occurs it is made explicit in the assessment.

13.4.19 Across the central and east London areas, there are natural variations in groundwater quality which affect the value/sensitivity of the groundwater receptor. Where the aquifer is known to be brackish/saline this reduces the potential use of the groundwater. Unless the groundwater is permanently unusable and where there is a viable aquifer, receptor value is primarily defined by quantitative status.

[iv] Principal aquifer - these are layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage.

[v] Secondary aquifer - these include a wide range of rock layers or drift deposits with an equally wide range of water permeability and storage. These include permeable layers capable of supporting water supplies at a local rather than strategic scale

[vi] Unproductive strata - these are formations of negligible permeability and generally regarded as not containing groundwater in exploitable quantities.

Vol 2 Table 13.4.2 Groundwater – receptor value/sensitivity quantity/resource criteria

Receptor value and/or sensitivity	Quantity (resources)					
	Groundwater resources	**Geological setting**	**Source Protection Zone**	**Licensed abstraction sources**	**Unlicensed abstraction sources**	**Groundwater-fed wetlands**
High	Principal aquifer	Hydraulic connection between upper and lower aquifers, high water table present	Within SPZ 1, 2 or 3	Within calculated capture zone and used for drinking water supplies. Or within calculated capture zone of a licensed GSHP scheme in a principal aquifer	Within calculated capture zone and used for drinking water supplies	Presence of EU or nationally designated site within 1km radius eg, SAC, Ramsar or SSSI
Medium	Secondary aquifer	Separation of upper and lower aquifers through layer of Lambeth Group (LG)		Within calculated capture zone and used for industrial/agriculture/ amenity supplies.	Within calculated capture zone and used for industrial/ agriculture/ amenity supplies.	Presence of locally designated site within 1 km radius
Low	Unproductive strata	Separation of upper** and lower aquifers* by London Clay and LG		Outside any calculated capture zone	Outside any calculated capture zone	No designated sites within a 1km radius

* *Lower aquifer – Upnor Formation, Thanet Sands and the Chalk*
** *Upper aquifer – River Terrace Deposits/gravels*

Vol 2 Table 13.4.3 Groundwater − receptor value/sensitivity quality criteria

Receptor value and/or sensitivity	Quality
	Salinity[9] (total dissolved solids in ppm)
High	Drinking water (<1000)*
Medium	Brackish water (1,000-30,000)
Low	Sea water (30,000-50,000)

**500ppm restriction on drinking water and 1000 ppm limit of drinking water*

Base case

13.4.20 The base case conditions are taken to be the same as the current baseline conditions. The last full year of baseline groundwater data available is for 2011.

13.4.21 No substantive changes in the groundwater base case as a result of other proposed major new developments are presented in the Project wide assessment (Vol 3 Section 10).

13.4.22 Where a new development, due to be complete before construction of the Thames Tideway Tunnel project, would introduce new receptors (such as a GSHP) these new receptors have been included in the list of identified receptors. However, the assessment of these receptors is qualitative, as the schemes are mainly at the feasibility stage and operating details were not available. In a very few incidences, where a licence for a GSHP has been granted for a new development, then these receptors have been assessed as part of the base case.

13.4.23 The application of the *WFD* and resultant measures may indirectly lead to some improvements in groundwater quality and levels across London but this is not certain and has therefore not been factored into the base case for groundwater.

13.4.24 Since groundwater varies in response to climate and anthropogenic influences, a range of scenarios are included in the site-specific base case sections of the site assessments and assessed accordingly (Vol 4 to 27). For example, if dewatering during construction is anticipated to lower groundwater levels by 3m, the lowest reasonable recent groundwater level has been used to define the base case and to assess the effect of dewatering. Conversely, if groundwater flooding is a potential issue, the maximum reasonable groundwater levels have been considered in the base case (see Section 13.9).

13.4.25 In defining the reasonable groundwater level base case, professional judgement has been used to determine the maxima and minima. This is because groundwater levels in London have changed significantly over the years. For example, the low groundwater levels experienced during the early to mid twentieth century have not been used as minima as they are not representative of current conditions; groundwater abstraction licensing is now carefully managed by the EA and as a result groundwater levels are relatively stable.

13.4.26 There are local influences where groundwater abstractions increase and decrease and cause a change in groundwater levels over time. Where these are known they have been included in the assessments. However, details of actual abstraction rates are not usually in the public domain, so the assessments rely on licensed rates.

13.5 Construction effects assessment

Assessment years

13.5.1 The assessment year considered in the assessment of construction effects on groundwater varies depending on the site-specific activities which could affect groundwater. The reasonable worst case is considered; for example, if dewatering is programmed to last for three years, the effects after pumping for three years have been considered. This means that there is not necessarily a common assessment year for groundwater assessment across all of the sites. The assessment year could lie between 2016 and 2022 depending on the individual site.

13.5.2 The construction effects assessment has considered the possibility that the construction programme could be delayed by up to a year. The sensitivity of the assessment to this temporal change is taken into account in the assessment of effects. Where, as a result of a change in programme, the findings of the assessment would be likely to vary materially from those for the proposed assessment year this has been highlighted in the construction effects assessment summary.

Assessment areas

13.5.3 The assessment areas for groundwater are not fixed at precise radii from sites or distances away from the tunnel alignment.

13.5.4 The main focus for the assessments has been as follows:

a. receptors lying within 1km of a shaft location

b. receptors lying within 1km either side of the tunnel alignment

c. aquifers through which the development would pass and any aquifer within approximately 10m of the anticipated lower construction or dewatering level.

13.5.5 The groundwater effects may extend further or less far away depending on the hydrogeological setting and the method of construction employed. The use of 1km radius from shaft locations or tunnel alignment means that a comprehensive coverage of all receptors has been ensured.

Methodology

13.5.6 The identification of likely significant construction effects on groundwater has been undertaken by quantifying the impact, assessing the value/ sensitivity of the receptor and then using the generic significance matrix presented in Section 3 General EIA methodology of this volume to determine the effect. This approach identifies potential sources, or ‘causes’ of impacts. It also identifies receptors, in this case groundwater resources, which could be impacted (see Vol 2 Table 13.4.2 and Vol 2 Table 13.4.3).

13.5.7 The presence of a 'cause' and a potential receptor does not always infer an impact. For a receptor to experience and impact from a source there needs to be a clear mechanism or 'pathway'. For example, construction activities in the London Clay, to the west, may be physically close to a groundwater abstraction from the underlying Chalk but with no hydraulic connection, no impact is likely to occur. In contrast, in the east where the Chalk is unconfined, a direct hydraulic connection may exist and potential for impacts on the identified receptor would exist.

13.5.8 The first stage of the assessment process is the review of the potential receptors (ie, the controlled waters, groundwater abstractors and groundwater dependent ecosystems) with the potential to be impacted by the development.

13.5.9 The construction activities at individual sites, connection tunnels and the main tunnel have the potential to impact groundwater receptors.

13.5.10 In assessing fully the significance of construction effects, the assessment has been split into a number of different categories:

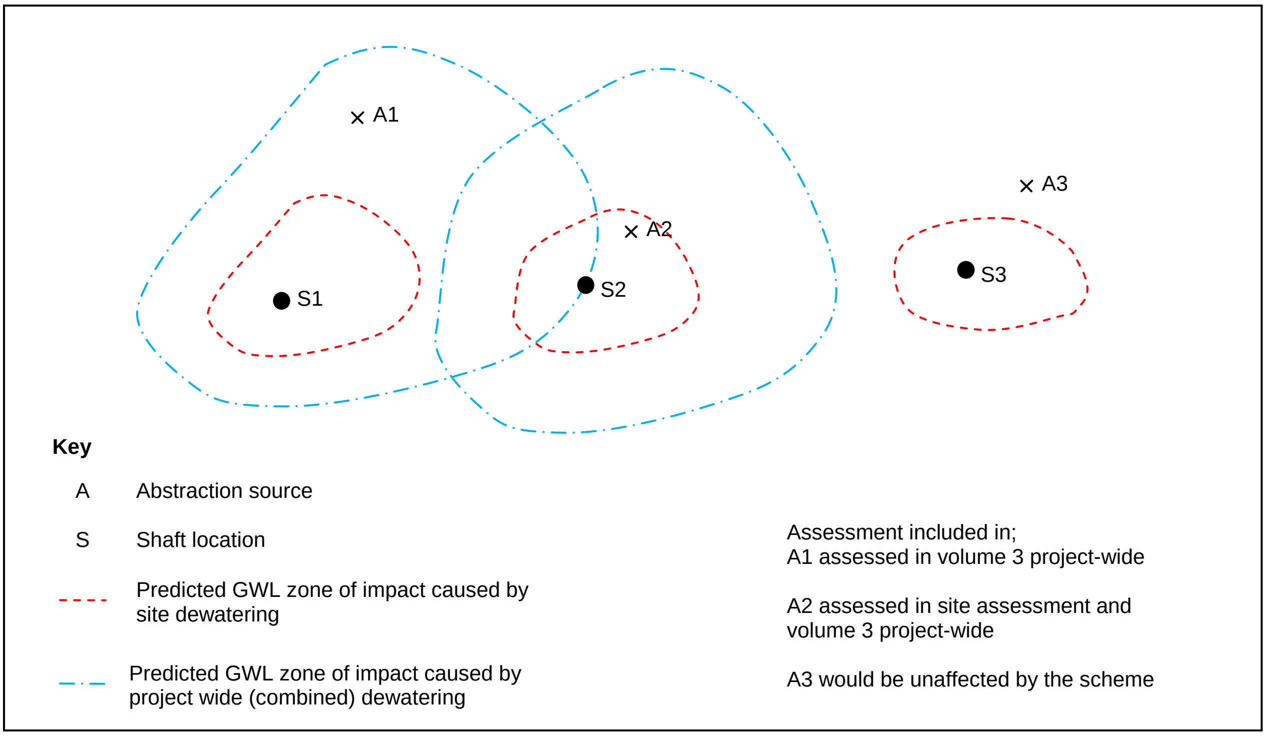
a. the dewatering of aquifers (see Section 13.8)

b. groundwater quality

c. the physical obstruction of groundwater flows (see Vol 2 Appendix H.2)

13.5.11 The assessment of likely significant effects has been undertaken both at a site level and at a project wide level. There is overlap between the assessment undertaken at both the site level and that undertaken for the project wide assessments with certain effects reported in both assessments. Specifically this relates to those effects on licensed abstractions in the lower aquifer as a result of construction dewatering during shaft construction. All effects on licensed abstractions are reported in the project wide assessment as well as site assessments (which require dewatering) where the abstraction is within the assessment area (see para. 13.5.4). Vol 2 Plate 13.5.1 shows the relationship between the scope of the project wide assessment and that of the site assessment.

Vol 2 Plate 13.5.1 Groundwater – schematic showing the overlap between site and project wide assessment



Significance criteria

13.5.12 The likely significant effects on groundwater have been determined with reference to the guidelines published by web-based Transport Analysis Guidance (The WebTAG, 2003)[10]; specifically the Water Environment sub-objective WebTAG Unit 3.3.11[vii]. The level of significance of an effect has been derived from measures of the magnitude of impact and the sensitivity of the receptors as described below.

Determining magnitude of impacts

13.5.13 The magnitude of a potential impact is determined based on the likely loss of the receptor (see Vol 2 Table 13.5.1). Potential impacts can be beneficial as well as adverse.

Vol 2 Table 13.5.1 Groundwater – impact magnitude criteria

Impact magnitude	Definition
High	Results in loss of receptor
Medium	Results in impact on integrity of receptor or loss of part of receptor

[vii] The methodology set out in this TAG Unit provides an appraisal framework for taking the outputs of the environmental impact assessment (EIA) process and analysing the key information of relevance to the water environment. The guidance provides a method, by which the significance of the identified potential impacts can be appraised consistently by decision makers. It is based on guidance prepared by the EA and builds on the water assessment methodology in Design Manual for Roads and Bridges (DMRB) 11:3:10.

Impact magnitude	Definition
Low	Results in temporary impact on receptor
Negligible	Results in an effect on receptor but of insufficient magnitude to affect its use/integrity

13.5.14 The quantification of impact for groundwater is based on a number of parameters and tests along with the application of professional judgement. The justification for each assigned magnitude of impact has been explained within the assessment text.

The dewatering of aquifers

13.5.15 Where dewatering is anticipated, the EA's London Groundwater Abstraction Licensing Policy, which was produced to restrict further abstraction in areas approaching their sustainable limits, has been used to identify those abstractions which could be impacted upon. The policy states that new consumptive licences from the Chalk are completely restricted in certain parts of London, whilst in other parts it is restricted to < $200m^3$/d annual average (EA, 2006)[11]. Where the proposed design involves dewatering in excess of this amount (without any mitigation) a high to medium impact has been assigned. The magnitude of this impact has been derived using the local assessment tests set out in the licensing policy and depends upon:

a. the long-term trend in groundwater levels over the several years in the vicinity of the site

b. how the levels at the site compare with the base of the London Clay, the aim being to manage abstraction to keep groundwater levels above the Thanet Sands

c. any recent abstraction developments in the vicinity of the assessment area, including any refusals on resources grounds within recent years

d. the proximity of the site to an existing or proposed Artificial Recharge Scheme (ARS)[viii].

13.5.16 In quantifying the magnitude of an impact it is necessary to consider the physical properties of the receptor. For example, if there is a deep Chalk borehole with a pump at a depth of 150m, 50m below the water table, a drawdown of 2m would have less impact than the same drawdown in a deep gravel borehole where the pump was 6m below the water table. In assessing the impacts of a given drawdown on a borehole the maximum assessed available drawdown (MAAD) is defined for each licensed abstraction source. The maximum level of drawdown is then compared to the MAAD. Vol 2 Table 13.5.2 provides a summary of the impact magnitude criteria applied to drawdown.

[viii] Artificial Recharge Scheme (ARS) - A process of injecting and re-abstraction into a groundwater body to enhance resource availability during periods of scarcity.

Vol 2 Table 13.5.2 Groundwater – quantity drawdown

Impact magnitude	Definition
High	Predicted drawdown would be where the maximum available drawdown is exceeded beyond 15 years
Medium	Predicted drawdown would be where the maximum available drawdown is exceeded beyond the construction period but not beyond 15 years.
Low	Predicted drawdown is within 20%* of the maximum available drawdown
Negligible	Predicted drawdown does not exceed the maximum available drawdown

** A tolerance of 20% is based on sensitivity analysis - the results of which are presented in Vol 3 Appendix H.2*

Groundwater quality

13.5.17 Another consideration is whether groundwater levels would be drawn down from the top of the Thanet Sands into the Chalk by the dewatering, beyond the managed levels of the Chalk. The concern with this process is that it may lead to deterioration in water quality within the Chalk. The EA, by controlling the volume of abstraction, tries to maintain piezometric heads[ix] in the Chalk above the top of Thanet Sands at all times. Vol 2 Table 13.5.3 summarises the impact magnitude associated with dewatering the Thanet Sands.

Vol 2 Table 13.5.3 Groundwater – quality Thanet Sands dewatering

Impact magnitude	Definition
High	Dewatering below the top of the Thanet Sands in a location where there is no historic evidence of dewatering in the past.
Medium	Dewatering below the top of the Thanet Sands predicted to occur for more than a year where there is historic evidence that the Thanet Sands have been dewatered
Low	Drawdowns occurring for less than a year where the Thanet Sands have previously been dewatered
Negligible	No drawdown below the top of the Thanet Sands

13.5.18 Where groundwater pollution or land contamination is present the magnitude of impact can vary with the nature of the pollution or

[ix] The level or pressure head to which confined groundwater would rise to in a piezometer if it is open to the atmosphere.

contamination. For example, an existing pollution plume within an aquitard[x] layer above an aquifer would have a greater impact than a small amount of contamination present at the near surface.

13.5.19 The assessment of the impact of mobilisation of contamination has considered the exceedances of standards, such as Environmental Quality Standards (EQS)[xi] or Drinking Water Standards (DWS). The persistence of the exceedances has also been considered, along with whether the substance is hazardous or non-hazardous. The assessment has then taken account of the nearest receptor ie, abstraction licence, and whether its location is down hydraulic gradient (the slope of the watertable drives the direction and velocity of flows). Vol 2 Table 13.5.4 provides a summary of how the magnitude of groundwater quality, pollution have been defined.

Vol 2 Table 13.5.4 Groundwater – quality pollution

Impact magnitude	Definition
High	Persistent exceedance of an EQS or DWS for a hazardous (List 1) substance and/or a potential receptor in existence down hydraulic gradient within 1km
Medium	Isolated exceedance of an EQS or DWS of a hazardous (List 1) substance and/or a potential receptor in existence down hydraulic gradient within 1km
Low	Exceedance of a standard for non-hazardous (List 2) substance and/or the receptor is down gradient but at a distance of greater than 1km
Negligible	No exceedances identified and/or receptors are located up hydraulic gradient of site

Physical obstruction

13.5.20 The presence of sub-surface construction activities, such as sheet piling in the upper aquifer may disrupt groundwater flow and alter groundwater levels. The response of an aquifer system would depend on the existing water levels and whether the overlying layer is confining. Where the overlying geological layers are in hydraulic continuity with the upper aquifer construction within the upper aquifer may result in a rise in water levels in the upper aquifer. Where the ground water level is close to the surface the introduction of a new subsurface structure could potentially

[x] Aquitard - a semi-permeable horizon that retards but does not fully prevent groundwater movement to or from an adjacent aquifer

[xi] Environmental Quality Standards (EQS) – An EQS is a standard generally defined by regulations which sets a maximum allowable concentration of a potentially hazardous chemical in a sample.

result in groundwater flooding. Vol 2 Table 13.5.5 shows how impact magnitude has been defined for physical obstruction.

Vol 2 Table 13.5.5 Groundwater – physical obstruction

Impact magnitude	Definition
High	The predicted rise in water levels is greater than 0.6m and near surface layers (Made Ground and Alluvium) are in hydraulic continuity with the upper aquifer and water levels are close to the surface <1mbgl
Medium	Predicted obstruction rise is up to 0.6m, there is hydraulic continuity between the near surface and upper aquifer and groundwater levels are up to 3mbgl
Low	Predicted obstruction rise is up to 0.6m, there is hydraulic continuity between the near surface and upper aquifer and groundwater levels are up between 3 and 6mbgl
Negligible	Near surface layer is confining the upper aquifer, in which case whatever the recorded piezometric level; any obstruction rise would simply mean a pressure change within the upper aquifer

Determining significance of effects

13.5.21 The significance of groundwater effects have been determined by combining the identified impact magnitudes, with the receptors affected by those impacts (taking into account their sensitivity), as set out in the generic significance matrix (presented in Section 3 General EIA methodology).

13.5.22 Vol 2 Table 13.5.6 defines the significance ratings for the assessment of groundwater effects. Effects that are either major or moderate beneficial/adverse are deemed significant.

Vol 2 Table 13.5.6 Groundwater – significance criteria

Significance of effect	Description
Major adverse	Permanent deterioration (by a hazardous substance) of a groundwater body. Permanent lowering of groundwater levels.
Moderate adverse	Temporary deterioration of groundwater quality. Temporary lowering of groundwater levels.
Minor adverse	Measurable deterioration in attribute, but of limited size and/or proportion.
Negligible	No significant impact on the economic value of the feature.
Minor	Measurable improvement in receptor/resource, but of

Significance of effect	Description
beneficial	limited size and/or proportion.
Moderate beneficial	Temporary improvement in groundwater quality or water levels during the project.
Major beneficial	Permanent beneficial improvement of a groundwater body, either quantity or quality related.

13.6 Operational effects assessment

Assessment years

13.6.1 The assessment year considered for the assessment of operational effects on groundwater is 2023 (Year 1 of operation).

13.6.2 The operation effects assessment has considered the possibility that the construction programme could be delayed by up to a year meaning that the scheme would become operational up to a year after 2023. The sensitivity of the assessment to this temporal change is taken into account in the assessment of effects. Where, as a result of a change in programme, the findings of the assessment would be likely to vary materially from those for the proposed assessment year this has been highlighted in the operation effects assessment.

Assessment areas

13.6.3 The assessment area is the same as that defined for the construction effects.

Methodology

13.6.4 The methodology followed for the assessment of operational effects on groundwater is the same as that outlined for the construction effects assessment with the exception that the categories for assessment are different.

13.6.5 In assessing fully the significance of operational effects, the assessment has been split into a number of different categories:

a. the physical obstruction of groundwater flows (see Vol 2 Appendix H.2)

b. seepage from the shaft

c. seepage into the shaft.

Significance criteria

13.6.6 The significance criteria used for the assessment of operational effects are the same as those used for the construction effects assessment (see Vol 2 Table 13.5.6).

Determining magnitude of impacts

13.6.7 The magnitude of operational impacts is based on the potential loss of a receptor as presented in Vol 2 Table 13.5.1.

Physical obstruction

13.6.8 Once operational, sub-surface barriers such as shafts and tunnels may obstruct groundwater movements. The sub-surface barriers to groundwater flow are different depending on the hydrogeological setting. In the case of the deeper aquifer, flows to a nearby abstraction source, if very close by, may be affected. In the case of the shallow aquifer, a build up of groundwater pressure behind a sub-surface structure may lead to a rise in groundwater levels and the increased potential for groundwater flooding in certain circumstances. As with physical obstruction during construction the magnitude of impact is dependent on a number of factors which are presented in Vol 2 Table 13.5.5.

Seepage from the shaft

13.6.9 Other potential operational impacts relate to the use of the tunnel to transfer combined sewer discharges. There is potential for seepage from the sub-surface structures into the surrounding groundwater bodies. However, the tunnel would seldom be full and over much of its length the operating pressure is less than the Chalk head, so the period of time and the length of tunnel over which seepage is possible are limited. The secondary lining of shafts and tunnels would limit seepage from these structures. Seepage calculations have been made and are included in Vol 2 Appendix H.3. The seepage from each of the shafts has been determined for both the upper and lower aquifers. The magnitude of impact would be higher where seepage calculations are large and form a significant proportion of nearby abstraction. A low impact would occur where seepage volume was a small proportion of any nearby abstraction.

Seepage to the shaft

13.6.10 For the majority of the time the tunnel would be empty so there is potential for inflows. The magnitude of this impact on water resources is based on the EA's abstraction licensing policy as described in Section 13.5. The secondary lining of all sub-surface structures would limit the amount of inflow. Vol 2 Table 13.6.1 defines the impact magnitude criteria for seepage to the shaft.

Vol 2 Table 13.6.1 Groundwater – seepage to the shaft

Impact magnitude	Definition
High	Loss of resource is equivalent to a major abstraction licence (>1000m3/d)
Medium	Loss of resource is >20 m3/d
Low	Loss of resource is <20m3/d
Negligible	Loss of resource <3m3/d (or 15% of 20 m3/d threshold)

Determining significance of effects

13.6.11 The determination of the significance of operational effects follows the same methodology as that described for the construction effects.

13.7 Cumulative effects assessment

13.7.1 The general approach to assessing cumulative effects is described in Section 3 General EIA methodology. The specific approach for groundwater is described below. The assessment years considered for the cumulative effects assessment remain as defined in Sections 13.5 and 13.6.

13.7.2 A comprehensive list of other developments within 1km of each site has been compiled. This list identifies developments which are:

a. under construction

b. permitted but not yet implemented and

c. submitted but not yet determined.

13.7.3 The assessment of cumulative effects has considered those other developments in categories a to c above that are programmed to be under construction or operational at the same time as the Thames Tideway Tunnel project.

13.7.4 A spreadsheet (see Vol 2 Appendix K.4) which uses the development schedules set out in Appendix N of Vols 4 to 27 has been used to review information about these other development, such as whether the proposed development would include a basement, a GSHP, an abstraction borehole, dewatering or Sustainable Drainage System (SuDS)[xii].

13.7.5 The method for assessing cumulative effects uses a qualitative approach and the findings have not been used to re-classify the significance of any effects identified from the main assessment (Sections 13.5 and 13.6).

Construction effects

13.7.6 For those parts of new developments which would be under construction at the same time as construction activities on the Thames Tideway Tunnel project, these have been subject to a construction cumulative assessment. These developments are highlighted in red on the spreadsheet (see Vol 2 Appendix K.4).

13.7.7 Where a development is complete during construction of the Thames Tideway Tunnel project, this would not require a cumulative assessment to be undertaken, as it has been assessed as part of the base case for the construction assessment. These developments are shown in green on the spreadsheet.

[xii] SuDS – sustainable drainage system which controls surface runoff by encouraging water to move naturally to below ground before eventually discharging to water courses

Operational effects

13.7.8 Similarly, for the operational phase if a new development is under construction at the same time as the operation of the Thames Tideway Tunnel project, this has been subject to an operational cumulative assessment. These developments are also shown in red on the spreadsheet (see Vol 2 Appendix K.4).

13.7.9 Where a development is complete during the operation of the Thames Tideway Tunnel project, this would not require a cumulative assessment to be undertaken, as it has been assessed as part of the base case for the operational assessment. These are shown in green on the spreadsheet.

13.8 Project-wide effects assessment

13.8.1 The general approach to assessing the likely significant effects, including project-wide effects, is described in Section 3. The specific approach for assessing project-wide groundwater effects is described below.

13.8.2 The specific approach for groundwater, involved the use of numerical groundwater modelling. A separate supporting modelling report is presented in Vol 3 Appendix H.2.

13.8.3 Groundwater by its nature is susceptible to project-wide effects from activities taking place at a number of sites. Dewatering during construction is an example of an activity that would potentially combine to increase the lowering of groundwater levels. This may also mean that less dewatering may be required at a site because water levels are already being drawn down from activities at nearby sites. These combined effects are taken into account using the principles of superposition[xiii] and are included within the numerical groundwater modelling where necessary.

13.8.4 The lower aquifer and licensed abstraction sources within this aquifer are the receptors capable of experiencing project-wide effects and are therefore presented in the project wide assessment. The effects of dewatering on licensed abstractions are also considered in the site specific assessments where licensed abstractions are within the assessment area of the site which could impact them directly (although these effects are presented in different places they are the same effects and can be identified by the licensed abstraction number). Vol 2 Plate 13.5.1 provides a schematic showing the relationship between the scope of the project wide assessment and the site assessment.

13.8.5 Where dewatering external to diaphragm walls is proposed at sites, the effects of mobilising poor quality groundwater on the lower aquifer and on nearby licensed abstractions are assessed in the site-specific assessments.

[xiii] The superposition principle states that the net response at a given place and time caused by two or more stimuli is the sum of the responses which would have been caused by each stimulus individually.

Assessment years

13.8.6 The overall peak in construction activities across all sites for groundwater is identified to be 2017 (Project Year 2 of construction); therefore this year is the assessment year applied to the project-wide construction assessment. The assessment year applied to the project-wide operational assessment is 2023 (Year 1 of the operational phase).

13.8.7 The assessment has considered the possibility that the construction programme could be delayed by up to a year (which would result in Year 1 of operation being delayed by the same amount). The sensitivity of the assessment to this temporal change is taken into account in the assessment. Where, as a result of a change in programme, the findings of the assessment would be likely to vary materially from those for the proposed assessment year this has been highlighted in the construction and operation effects assessments.

Assessment areas

13.8.8 The assessment area is the same as that defined for the construction and operational effects in para. 13.5.4.

Methodology

13.8.9 The methodology followed for the project-wide assessment is the same as that outlined for the site-specific construction and operational effects assessment.

Significance criteria

13.8.10 The significance criteria are the same as those used for the site-specific construction and operational effects assessment.

Determining magnitude of impacts

13.8.11 The magnitude of impact criteria applied for the project-wide assessment are as described in Section 13.5 and Section 13.6 for construction and operation, with the exception of the reduction in pollution which is described in the following section.

Reduction in pollution

13.8.12 There are parts of east London where the tidal Thames is in direct hydraulic connection with both the upper and lower aquifers. By virtue of the Thames Tideway Tunnel project cleaning up the river quality, the potential exists for net benefit on the underlying aquifers.

13.8.13 The proportion of leakage from the River Thames into the aquifer remains un-quantified, as result any impact magnitude can only assessed qualitatively.

13.8.14 Vol 2 Table 13.8.1 provides a summary of the impact magnitude criteria applied to loss of storage.

Vol 2 Table 13.8.1 Groundwater – quality reduction in pollution

Impact magnitude	Definition
High	Reduction in pollution leads to permanent improvement in groundwater quality status of the groundwater body
Medium	Reduction in pollution leads to temporary improvement in groundwater quality status of the groundwater body
Low	Reduction in pollution leads to measurable change in groundwater quality
Negligible	Reduction in pollution does not lead to measurable change in groundwater quality

Project-wide cumulative effects

13.8.15 All of the developments identified are included on the cumulative spreadsheet (see Vol 2 Appendix K.4).

13.8.16 The project-wide cumulative effects have been assessed qualitatively and are not included within the numerical modelling (see Vol 3 Section 10 and the supporting modelling report Vol 3 Appendix H.2).

Construction

13.8.17 Those major projects which would be under construction at the same time as the Thames Tideway Tunnel project require a project-wide cumulative assessment to be undertaken. These projects are shown in red on the spreadsheet (see Vol 2 Appendix L).

13.8.18 Where a major project would be complete during construction of the Thames Tideway Tunnel project, this would not require a cumulative assessment to be undertaken. These projects are shown in green on the spreadsheet.

Operation

13.8.19 Similarly, for the operation phase if a major project would be under construction during the operational phase of the Thames Tideway Tunnel project, this would require a project-wide cumulative assessment to be undertaken. These developments are shown in red on the spreadsheet.

13.8.20 However, where a project is complete during the operation of the Thames Tideway Tunnel project, this would not require a cumulative assessment to be undertaken. These are shown in green on the spreadsheet.

13.9 Assumptions and limitations

13.9.1 This section details general assumptions and limitations associated with the groundwater assessment. Site-specific assumptions and limitations are detailed in Vol 4 to 27 (Section 13 Water resources – groundwater) and project-wide assumptions are included in Vol 3 Section 10.

Assumptions

13.9.2 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.

13.9.3 The list of groundwater receptors is based on the best available information provided by the EA on abstractions (both licensed groundwater abstractions and GSHP schemes). Local authorities have also provided information on unlicensed abstractions.

13.9.4 Details of actual abstraction rates are not usually in the public domain, so the assessments rely on licensed rates where no further detail is available.

13.9.5 Selected licence holders have been approached directly for further details on their individual sources such as pump depths and pumped water levels. The process of gathering this information and data collected is presented in Vol 2 Appendix K.5.

13.9.6 The ground investigations undertaken in 2009 have recorded depths and thicknesses of geological strata to an accuracy of two decimal places. In comparing these depths to that of the shaft and interception chamber construction depths, it has been necessary to apply a similar of accuracy to all measurements contained within the groundwater sections of Vol 4 to 27. The use of an accuracy of two decimal places has been applied for the purposes of the assessment of likely significant effects but may be subject to change.

13.9.7 The assessment of seepage to and from the shafts and tunnels applied for both the site specific and project wide assessments has assumed a seepage rate of $1l/m^3/d$ (the reasons for selecting this figure are outlined in Vol 2 Appendix K.6).

13.9.8 In the case of tunnel chainages or lengths, these are included in the project-wide assessment to the nearest 10m in Vol 3 Section 10.

13.9.9 Works have been assumed as per the construction phasing plans. Movement within the zones shown on the works parameter plans would not change the outcome of the assessment.

Limitations

13.9.10 Pumping tests have not been undertaken as part of the ground investigations.

13.9.11 Groundwater monitoring data have been obtained typically from one borehole (or monitoring horizon) within each of aquifers (upper and lower) at each site; this has meant that hydraulic gradients[xiv] could only be estimated across the site. In addition, the range of hydrological conditions experienced during the monitoring period (2010-2012) has not included a prolonged wet winter period when exceptionally high groundwater levels might occur.

[xiv] Hydraulic gradient – the slope of the water table which drives groundwater movement

13.9.12 The detail provided within the ES on the location of licensed abstractions has been informed by guidance provided by Defra on the sensitivity of groundwater sources. As such the location of abstraction sources used for food or drink purposes have not been shown on figures and where distance from a Thames Tideway Tunnel site is described it is only done so as “within 1km of the site”.

13.9.13 Despite the limitation identified above, the assessments of likely significant effects on groundwater are in general considered robust.

13.10 Mitigation

Construction

13.10.1 The Thames Tideway Tunnel project has been designed to minimise environmental effects. The construction design/methods take account of groundwater considerations in the design and the construction of shafts. Typical features include:

a. the sealing out of the upper aquifer, in the west using sheet piles[xv] and in the east by secant piled walls[xvi]

b. reducing flows as much as possible by constructing either a diaphragm wall[xvii] or sinking caisson[xviii] structures with buried footings which are jacked into the ground

c. the use of ground treatment[xix] techniques to stem fissure flows if required.

13.10.2 In the case of the tunnel(s), different tunnelling techniques would be used to suit geological and hydrogeological conditions. In the east, the Chalk is likely to provide higher flows and to minimise inflows to tunnel in this area it may be necessary to pre-treat the ground.

13.10.3 Where such measures form part of the project, they are identified in Volume 1 Introduction to the Environmental Statement (for the tunnel itself) and Section 3 of Vol 4 to 27 (for each site) and have been considered as embedded measures within the assessment.

13.10.4 Where the assessment indicates significant effects having taken account of embedded measures, mitigation has been identified as appropriate. Solutions for dealing with construction effects include:

[xv] Sheet piling - a sub-surface barrier installed around construction sites in order to control inflows of shallow groundwater

[xvi] Secant piling - a sub-surface barrier installed around construction sites in order to control inflows of shallow groundwater typically formed of intersecting concrete or overlapping shafts of concrete.

[xvii] Diaphragm wall - a sub-surface barrier installed around construction sites in order 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, to increase the length of the flow path and hence reduce the amount of groundwater inflows

[xviii] Caisson - a reinforced concrete surround used to line a shaft site

[xix] Ground treatment - the controlled alteration of the state, nature or mass behaviour of ground materials in order to achieve an intended satisfactory response to existing or projected environmental and engineering plans.

a. provision of alternative water supply

b. altering pump depths and/or the operation of sources

c. remediation to prevent spread of pollution

d. water level management plans for environmental designated areas

e. moving dewatering boreholes inside the diaphragm wall.

Operation

13.10.5 The Thames Tideway Tunnel project has been designed to minimise environmental effects. The design takes account of groundwater considerations including principally the use of a lining on both the shafts and tunnels. This feature would reduce the amount of seepage both:

a. into the shaft or tunnel when empty, thereby minimising the loss of resources from surrounding aquifers

b. out of the shaft or tunnel, on the few occasions when the tunnel is full, thereby preventing any deterioration in groundwater quality in both the upper and lower aquifers.

13.10.6 Where such measures form part of the project, they are identified in Vol 1 (for the tunnel) and Section 3 of Vol 4 to 27 (for each site), and have been considered as embedded environmental design within the assessment.

13.10.7 Where the assessment indicates significant effects, after taking account of embedded environmental design, mitigation has been identified as appropriate.

13.11 Residual effects assessment

13.11.1 Where mitigation measures are proposed, the significance of the residual effects has been assessed by re-modelling in the case of dewatering (see Vol 3 Section 10 Supporting modelling report and Vol 3 Appendix H.2).

13.11.2 Other residual effects have been assessed on a quantitative basis in certain instances (eg, obstruction of groundwater flows) and qualitatively through the application of professional judgement in other cases.

13.11.3 Where no mitigation measures have been proposed, the significance of the residual effects would remain as identified through the relevant assessment (construction, operational or project-wide).

References

[1] *The Water Act* (1991). Available at: http://www.legislation.gov.uk/ukpga/1991/57/contents.

[2] *The Water Act* (2003). Available at: http://www.legislation.gov.uk/ukpga/2003/37/contents.

[3] 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.

[4] Defra. *2006/118/EC Groundwater Daughter Directive (200*6). Available at: http://archive.defra.gov.uk/environment/quality/water/wfd/daughter-dirs.htm.

[5] *The Groundwater (England and Wales) Regulations 2009* (2009). Available at: http://www.legislation.gov.uk/ukdsi/2009/9780111480816/contents.

[6] Groundwater Protection: *Principles and Practice – Consultation summary document* (October 2011).

[7] *The Environmental Permitting (England and Wales) Regulations 2010* (2010). Available at: http://www.legislation.gov.uk/ukdsi/2010/9780111491423/contents.

[8] Environment Agency and ESI. London Basin Aquifer Conceptual Model. ESI Report Reference 60121R1 (June 2010).

[9] The Engineering Tool Box Website. *Salinity*. Available at: http://www.engineeringtoolbox.com/water-salinity-d_1251.htm. Accessed June 2012.

[10] The WebTAG. *Web-based Transport Analysis Guidance*; specifically the Water Environment Sub-Objective WebTAG Unit 3.3.11 (2003).

[11] Environment Agency. *The London Catchment Abstraction Management Strategy (CAMS).* Final Strategy Document (2006). Available at: http://publications.environment-agency.gov.uk/PDF/GETH0406BKRM-E-E.pdf.

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.02**

Volume 2: Environmental assessment methodology

Section 14: Water resources - surface water

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

Hard copy available in

Box **16** Folder **A**
January 2013

Thames Tideway Tunnel

Creating a cleaner, healthier River Thames

This page is intentionally blank

Thames Tideway Tunnel

Environmental Statement

Volume 2: Environmental assessment methodology

Section 14: Water resources – surface water

List of contents

Page number

List of tables

Page number

This page is intentionally blank

14 Water resources – surface water

14.1 Introduction

14.1.1 This section sets out the methodology for assessing the likely significant effects of the Thames Tideway Tunnel project on surface water resources.

14.1.2 The methodology outlined in this section has been applied to all sites, unless otherwise indicated in the site assessment volumes. The methodology for assessing project-wide effects is also described.

14.1.3 The need for an assessment of surface water effects results from the potential for the project to have significant effects on surface water resources during the construction phase. The project has the potential for significant effects on surface water quality during operation as a result of the interception of combined sewage overflows (CSOs) that would otherwise discharge to the tidal Thames.

14.1.4 The topic specific methodology presented in this section builds upon the general assessment methodology summarised in Section 3 of this volume and develops this to take account of the range of likely significant environmental effects on surface water arising from the construction and operation of the project.

14.2 Engagement

14.2.1 The general approach adopted regarding engagement is summarised in Section 2 of this volume.

14.2.2 Comments relevant to the surface water assessment are detailed in Vol 2 Appendix L.1.

14.2.3 A Technical Working Group (TWG) was established with the Environment Agency (EA). The TWG has been used to discuss the scope of the surface water assessments and water quality modelling undertaken for the Thames Tideway Tunnel project. Comments from the EA provided during the consultation stages (eg, scoping and phase two consultation) were discussed at the TWGs. The EA has provided advice on CSO excursion areas, this stated that CSOs below Tower Bridge would only impact the Thames Middle waterbody and those upriver of Tower Bridge would impact both the Thames Upper and Thames Middle waterbodies.

14.2.4 Comments of relevance to the surface water assessment were also received from other stakeholders during the consultation phases (including the scoping, phase two consultation and Section 48 publicity). Comments were received from the Infrastructure Planning Commission (IPC), the London Borough (LB) of Southwark and the Port of London Authority (PLA). The development of scour was highlighted as a key issue by a number of stakeholders during Section 48 publicity, this included the EA, the Crown's Estate and the Marine Management Organisation (MMO).

14.2.5 The comments received during engagement have informed the assessment presented in this volume and many of the measures presented in the *Code of Construction Practice (CoCP)*, in particular Section 8. The *CoCP* is provided in Vol 1 Appendix A. It contains general requirements (Part A), and site specific requirements (Part B).

14.3 Legislation and guidance

14.3.1 The assessment of likely significant effects on surface water resources has been informed by the requirements of international and national legislation, policy and guidance including the following:

a. Urban Waste Water Treatment Directive (UWWTD)[1].

b. Urban Waste Water Treatment Regulations (UWWTR)[2].

c. Water Framework Directive (WFD)[3].

d. The Water Environment Regulations[4].

e. *Thames River Basin Management Plan* (RBMP) (EA, 2009)[5].

f. *Waste Water National Policy Statement* (NPS) (Defra, 2011)[6].

g. EA's *WFD assessment guidance* (EA, 2009)[7].

h. Water Environment Sub Objective WebTAG Unit 3.3.11 methodology[8].

14.3.2 The primary objective of the Thames Tideway Tunnel project is to capture discharges into the tidal Thames from the 34 most polluting of the 57 CSOs along the tidal Thames. Should nothing be done to address the current situation, continuing population growth and incremental increases to impermeable areas across London are expected to increase the volume and frequency of discharges to the river. Such increased discharges would have associated increased adverse environmental impacts.

14.3.3 The WFD aims to protect and enhance the quality of the water environment by requiring member states to classify the current 'Status' (or Potential) of waterbodies and set a series of objectives for maintaining or improving waterbodies so that they maintain or reach 'Good Status' or 'Good Potential'. The project is also an important element in ensuring the tidal Thames meets the objectives of the WFD. The RBMP developed for the tidal Thames as part of the requirements of the WFD, states that the five sewage works upgrades[i] "represent the primary measures to address point source pollution from the sewer system and are fundamental to the achievement of good status in this catchment".

a. The overall WFD Status/Potential for surface waterbodies is made up of two main elements - an Ecological status/potential and (where applicable) a Chemical status.

14.3.4 Ecological status classification comprises the consideration a number of quality elements:

[i] The upgrades comprise five separate improvement projects at Thames Water's five Tideway sewage treatment works (STWs): Beckton, Crossness, Mogden, Riverside and Long Reach.

a. the condition of biological elements (eg, presence and diversity of fish);

b. water quality (physico-chemical elements and specific pollutants)

c. hydromorphological elements (ie, the amount of water and physical condition).

14.3.5 Ecological status is recorded on a scale of high, good, moderate, poor or bad, where ‘high’ represents largely undisturbed conditions. Good status represents slight deviation from largely undisturbed conditions, whilst moderate status represents a moderate deviation from undisturbed conditions. Waterbodies achieving a status below moderate are classified as poor or bad. The ecological status classification is determined by the worst (lowest) scoring quality element. For example, if a waterbody achieved ‘good status’ for physico-chemical assessments, but only achieved ‘moderate status’ for the biological assessment; it would be classed overall as having ‘moderate ecological status’. It is also important to note that water quality supporting elements can only influence status down to moderate; as such, only biological elements can determine poor or bad status.

14.3.6 Chemical status is assessed based on compliance with environmental standards for chemicals that are priority substances and/or priority hazardous substances[ii]. Chemical status is recorded as ‘good’ or ‘fail’. Chemical status is determined by the worst scoring chemical approach. Assessment of pollutants is only required in waterbodies where there are known discharges of these pollutants.

14.3.7 The overall classification of current status or potential under the WFD is a detailed process. Reference should be made to the United Kingdom Technical Advisory Group[9] (UKTAG) guidance, as given in the RBMP (EA, 2009)[10], for the full methodology. For transitional waters and estuaries (ie, the tidal Thames) only dissolved oxygen and (DO) total inorganic nitrogen standards have been proposed by the UKTAG.

14.3.8 The WFD sets out targets within six year planning cycles commencing from 2009 (ie, targets are set for 2015 then 2021, 2027 etc). Under the current cycle, default 2015 targets of good status were set for all UK water bodies. The RBMP recognises that some waterbodies may not achieve good status, due to modifications such as flood defence or navigation. In these cases, the waterbody is classified as an Artificial Water Body (AWB) or Heavily Modified Water Body (HMWB). Where these targets cannot be achieved alternative targets may be set. HMWBs have an additional classification step that considers whether all the mitigation measures that are required in order to reach good potential are in place. If they are not, the ‘potential’ of that waterbody is limited to moderate.

14.3.9 For the waterbodies potentially affected by the proposed development, outlined in Vol 2 Table 14.4.1, these alternative targets are to achieve good potential by 2027. No interim targets have been set for 2015 or 2021

[ii] Priority substances are substances defined in accordance with Article 16(2) and listed in Annex X of the WFD.

for these waterbodies, which means that the target status for 2015 and 2021 will remain as for the current status.

14.3.10 The Regents Canal was constructed in the early 19th century and is classified as an AWB. The remainder of the waterbodies potentially affected by the proposed development are classified as HMWBs. All waterbodies potentially affected by the proposed development have a target of good potential rather than good status.

14.3.11 The table below presents the requirements within the NPS relevant to surface water resources and explains how the requirements have been addressed within the ES. The Table also gives the location of the relevant material.

Vol 2 Table 14.3.1 Surface water – requirements of the NPS and how they have been addressed

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
The ES should set out how the proposal will take account of the projected impacts of climate change (Section 3.6.6). **The applicant** should use the latest set of UK Climate Projections to ensure they have identified appropriate adaptation measures (Section 3.6.7) **The decision maker** should be satisfied that there are not critical features of the design of new waste water infrastructure which may be seriously affected by more radical changes to the climate beyond that projected in the latest set of UK climate projections (Section 3.6.10).	The impact of the proposed development on water quality has been simulated using two modelling packages, the InfoWorks wastewater modelling package and the QUESTS river water quality modelling package. To take account of the projected impacts of climate change, a modelled simulation has been used that is based on UK climate projections. This includes assessment of the low, medium and high emission scenarios and the 10%, 50% and 90% estimate range for rainfall in 2080 as well as population growth predictions. Adaptation measures that may be required have been identified in the *Resilience to Change Report*. There are no features of the Thames Tideway Tunnel project that would be seriously affected as described in Section 3.6.10 of the NPS. The Thames Tideway Tunnel project is required in any event, irrespective of whether there is some loss of benefit over time.	Vol 3 Section 14 *Resilience to Change Report*

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
The applicant is advised to make early contact with relevant regulators, including the Environment Agency (EA) and the MMO, to discuss their requirements for environmental permits and other consents (Section 3.7.7).	As explained in Section 14.2, a TWG was set with the EA. This working group has met on an approximately 6-monthly basis throughout the production of the pre-application process, with additional consultation where required. The MMO has been consulted at all stages of consultation (including scoping). Meetings have also taken place between the surface water teams and the MMO to discuss comments relating to the assessment, in particular the assessment of scour.	Vol 2 Appendix L.1
The **decision maker** should be satisfied that - in the case of potentially polluting developments: •the relevant pollution control authority should be satisfied that potential releases can be adequately regulated under the pollution control framework; and •the effects of existing sources of pollution in and around the site are not such that the cumulative effects of pollution when the proposed development is added would make that development unacceptable, particularly in relation to statutory environmental quality limits. (Section 3.7.8)	The *Code of Construction Practice* (*CoCP*) *Part A* includes a number of measures to minimise the potential for impacts to surface waters during construction, including discharge of pollutants via surface water drains. The operation of the Thames Tideway Tunnel project would enable the interception of CSO that would otherwise spill to the tidal Thames and therefore would result in an improvement in the water quality of the tidal Thames through the reduction in discharges of polluting substances.	*Code of Construction Practice* (CoCP) Part A and Vol 4-27 Section 14
The applicant should identify any significant adverse health impacts in the ES, and identify measures to avoid, reduce or compensate for these impacts as appropriate (Section 3.10.5)	The CSO interception by the Thames Tideway Tunnel project would reduce the discharge of pathogens that are associated with the combined sewage, which would greatly improve the conditions for recreational users	Thames Water. *Thames Tideway Strategic Study* (February 2005) and Vol 4-27 Section 14

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
	of the tidal Thames. No adverse impacts on health have been identified in relation to surface water resources.	
Where the project is likely to have effects on the water environment, **the applicant** should undertake an assessment of the existing status of, and impacts of the proposed project on water quality, water resources and physical characteristics of the water environment as part of the Environmental Statement (ES) or equivalent (Section 4.2.2) The ES should describe: • the existing quality of waters affected by the proposed project and the impacts of the proposed project on water quality, noting any relevant existing discharges, proposed new discharges and proposed changes to discharges; • existing water resources affected by the proposed project and the impacts of the proposed project on water resources, noting any relevant existing abstraction rates, proposed new abstraction rates and proposed changes to abstraction rates (including any impact on or use of mains supplies and reference to Catchment Abstraction Management Strategies); • existing physical characteristics of the water environment (including quantity and dynamics of flow) affected by the proposed project and any impact of physical	The ES has identified the current status of each of the RBMP waterbodies that could be affected by the project, and the water quality effects on these waterbodies have been modelled. The ES discusses the changes to CSO spill frequency, duration and volume that would result from the operation of the Thames Tideway Tunnel project. A Water Framework Directive assessment has been carried out, which assesses the effects of the project on the hydromorphology of the tidal Thames and its tributaries; this has also referred to the outputs of fluvial modelling studies. The ES has also considered any cumulative effects Impacts on potable groundwater abstractions is assessed by the water resources – groundwater sections of the ES.	Vol 4-27 Section 14, Vol 3 Appendix L.1 and Vol 3 Section 14 Water Framework Directive Assessment, (Vol 3 Appendix L.2). Vol 4-27 Section 13

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
modifications to these characteristics; • any cumulative effects.		
The applicant should assess the impact of the proposal on existing abstractions that currently benefit from informal and indirect effluent re-use (Section 4.2.4).	Existing abstractions would benefit from improvements in water quality as a result of the operation of the Thames Tideway Tunnel project. These small benefits have not been assessed on individual basis; rather an overall beneficial effect has been inferred from the improved water quality in the tidal Thames.	Vol 3 Appendix L.1 and Vol 3 Section 14
The **developer** should also assess the potential water resources benefits that could arise from changes to effluent discharges as a result of the proposal (Section 4.2.4).	The operation of the Thames Tideway Tunnel project would enable the interception of CSOs that would otherwise spill to the tidal Thames and therefore would result in benefits to the water quality of the tidal Thames through the reduction in discharges of polluting substances.	Vol 4-27 Section 14
The **decision maker** should be satisfied that a proposal has regard to the River Basin Management Plans and meets the requirements of the Water Framework Directive (including Article 4.7) and its daughter directives, including those on priority substances and groundwater. The specific objectives for particular river basins are set out in River Basin Management Plans (Section 4.2.8).	A Water Framework Directive assessment has been carried out, which assessed the effects of the project on the RBMP objectives.	Water Framework Directive Assessment (Appendix L.2)
The risk of impacts on the water environment can be reduced through careful design to facilitate adherence to good pollution control practice. For example, designated areas for	The CoCP *Part A* includes a number of measures to minimise the potential for impacts to the water environment during construction, including impacts such as discharge of pollutants	*CoCP Part A* and Vol 4-27 Section 14

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
storage and unloading, with appropriate drainage facilities, should be clearly marked (Section 4.2.11)	via surface water drains.	
The impact on local water resources can be minimised through planning and design for the efficient use of water, including water recycling (Section 4.2.12).	The design principles include a commitment to the efficient use of water through the commitment that site drainage shall be designed to comply with the National Standards for Sustainable Drainage Systems under the Flood and Water Management Act 2010. The operation of the Thames Tideway Tunnel project would enable the interception of CSO that would otherwise spill to the tidal Thames and therefore would result in an improvement in the water quality of the local water resources ie, the tidal Thames.	*Design Principles* report (Section 3). See Vol 1 Appendix B) Vol 4-27 Section 14
Where relevant, **the applicant** should undertake coastal geomorphological and sediment transfer modelling to predict and understand impacts and help identify relevant mitigating or compensatory measure (Section 4.6.6)	The construction of in-river structures and in particular the temporary cofferdams could change flows in the vicinity of the site, leading to scour or deposition of sediments. An assessment of fluvial and sediment transport has been undertaken to assess the effects of the in-channel works, for both the construction and operation phases of the project.	Vol 4-27 Section 14 Vol 3 Appendix L.3
For any projects involving dredging or disposal into the sea, **the applicant** should consult the MMO at an early stage. The applicant should also consult the MMO on projects which could impact on coastal change, since the MMO may also be involved in considering other projects which may have related coastal	The MMO has been consulted at all stages of consultation.	Vol 2 Appendix L.1.

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
impacts (Section 4.6.8).		
The decision maker should not normally consent new development in areas of dynamic shorelines where the proposal could inhibit sediment flow or have an adverse impact on coastal processes at other locations. Impacts on coastal processes must be managed to minimise adverse impacts on other parts of the coast. Where such proposals are brought forward, consent should only be granted where the decision maker is satisfied that the benefits (including need) of the development outweigh the adverse impacts (Section 4.6.11)	An assessment of the fluvial and sediment transport has been undertaken to assess the effects of the in-channel works, for both the construction and operation phases of the Thames Tideway Tunnel project. In addition, the WFD assessment has assessed the effects of the proposed foreshore and in-river structures on hydromorphology.	Vol 3 Appendix L.3 Vol 3 Appendix L.2
The decision maker should ensure that applicants have restoration plans for areas of foreshore disturbed by direct works and will undertake pre- and post-construction coastal monitoring arrangements with defined triggers for intervention and restoration (Section 4.6.12).	The effects of the proposed development on the foreshore would be monitored during construction and mitigation provided if effects (primarily scour) exceeded trigger values. These trigger values would take account of the competence of the presumed existing scour protection and the risk to adjacent structures	Vol 3 Appendix L.4

14.4 Baseline data collection

14.4.1 Baseline data has been collected from desk-based sources, including modelling, and site walkovers as described below.

Desk based baseline data

14.4.2 Data to support the formulation of the base case has been collected from the following sources:

a. River Thames RBMP (EA, 2009)[11].

b. Automatic Quality Monitoring Station (AQMS) and spot sample water quality data for the tidal Thames, as supplied by the EA[12].

c. Computational model simulations of the sewer network (including CSO operation).

d. Records of contamination at or adjacent to the proposed construction sites as reported in the land quality sections of the site assessment volumes (Volumes 4 to 27).

14.4.3 Data on DO levels have been collected from AQMS for key rainfall events to inform the project-wide assessment. These DO levels have been plotted with half-tide correction to obtain a representation of the DO profile along the length of the tidal Thames over time (see Volume 3 Project-wide assessment Section 14).

Computation modelling simulations

14.4.4 Simulations from computational models have been used to categorise the operation of the existing sewer network system and its effect on the tidal Thames water quality conditions. These simulations have been used to predict the base case conditions once other major schemes affecting water quality in the tidal Thames have come into operation as well as the proposed development itself. The models that have been used to determine the current baseline, base case and development case are described below (see Vol 3 Appendix L.1 for further detail of the modelling carried out).

Thames Water's wastewater catchment and water quality modelling

14.4.5 Thames Water characterises the operation of the sewer network in London through the use of a series of models. Catchment models for the five sewage treatment works (STWs) (Mogden, Beckton, Crossness, Long Reach and Riverside) have been developed by Thames Water. Each of the catchment models is able to represent flow and water quality conditions in each of the main network catchments and predict frequency, volume and duration of spills from CSOs in response to rainfall events. The catchment models represent dry weather flow[iii] (DWF) and storm flow and water quality conditions in each catchment's main sewer network and predict the frequency, volume and duration of CSO spills in response to rainfall events.

14.4.6 Future conditions in the tidal Thames have been simulated using the InfoWorks CS wastewater modelling package and the QUESTS river water quality model (WQM). WRc developed the QUESTS WQM on behalf of the EA and the Port of London Authority (PLA). The model predicts effects on the DO levels of the tidal Thames from CSO discharges and STW discharges as well as changes in natural processes. The QUESTS model was used during the Thames Tideway Strategic Study (*TTSS*) (Thames Water, 2005)[13]. The remit of which was to identify and develop potential solutions to the CSO discharges, with the ultimate aim of

[iii] Dry weather flow is foul water flow contribution during periods of dry weather

improving the water quality of the tidal Thames and its ecology (see Section 5 ecology – aquatic for further discussion of the TTSS).

14.4.7 The models described above have been used to define five modelled scenarios as follows:

a. Scenario 1 which is the current operation of the CSOs in response to different rainfall events, both in terms of the quantity and quality of the discharged flow. This has been modelled as a scenario which uses 2006 population figures, current rainfall data and existing sewage works capacities.

b. Scenario 2 is the base case which incorporates the impact that predicted changes in population would have on wastewater flows in London's sewer network by 2021, as well as the effect of other major schemes which are also likely to affect water quality in the tidal Thames. The latter includes the effect of the sewage works upgrades at Mogden, Beckton, Crossness, Long Reach and Riverside STWs and the Lee Tunnel once brought into operation.

c. Scenario 3 is the proposed development case once the Thames Tideway Tunnel project is in place and includes the base case described under Scenario 2. This scenario is only applicable to the operational effects assessment.

d. Scenario 4 is the 2080 base case without the Thames Tideway Tunnel project. This simulation includes predicted population estimates, sea level change and estimated river and environmental conditions. This scenario also assumes that the Lee Tunnel and proposed sewage works upgrades are in place.

e. Scenario 5 shows the effects of climate change. This uses predicted 2080 conditions including population estimates, sea level change and estimated river and environmental conditions. This scenario assumes that the Lee Tunnel, STW improvements and Thames Tideway Tunnel project are all in place. As above, this scenario is only applicable to the operational effects assessment.

14.4.8 The full year CSO performance along the tidal Thames for the five scenarios described above has been assessed against rainfall data for the 1979-1980 Typical Year. The Typical Year is a single water year from October 1979 to September 1980 selected from the 1970 to 2011 rainfall records and best represents the average rainfall over the Beckton and Crossness catchment.

14.4.9 The water quality assessment of the tidal Thames for the five scenarios described above have also been assessed against 242 summer rainfall events selected with climatic conditions to have an impact on DO levels in the tidal Thames. Conditions and rainfall are based on a CTP (compliance testing procedure) established during the *TTSS*. The CTP rainfall events were selected from rainfall data from 1970 to 2010.

Hydrodynamic estuary model

14.4.10 In conjunction with HR Wallingford, the EA has developed a 2-dimensional hydrodynamic model of the tidal Thames which can be used to predict changes in flow, flow velocities and vectors, and water levels as a result of changes to the hydromorphology of the tidal Thames and its foreshore.

14.4.11 This model has been used to predict the current and base case hydrodynamic flow conditions during construction and operation of works required in the foreshore. The results of the modelling have been used to inform the scour modelling described below.

Scour, sediment release and accretion modelling

14.4.12 Modelling has been undertaken to assess the potential scour that could arise from the in-river structures proposed at the foreshore sites. Modelling of the possible accretion caused by the temporary and permanent works at each of the foreshore sites has also been carried out. Details of the scour methodology are provided in Vol 3 Appendix L.3.

14.4.13 The volume of sediment that could be released from construction of the Thames Tideway Tunnel project sites from activities including piling, dredging, campsheds, barge movement and sediment loss during transfer has been calculated. Details of the methodology are provided in the *Habitats Regulation Assessment*. The predicted sediment levels have been compared against the current levels of sediment contained within the tidal Thames.

Field survey baseline data

14.4.14 No field surveys have been carried out for the surface water assessment, as it has been agreed with the EA that the existing water quality sampling carried out by the EA on the tidal Thames would provide sufficient baseline data for this assessment.

14.4.15 Site walkover visits have been undertaken (in November 2010 and October 2011) during which:

a. observations were made of the surrounding conditions at each of the sites

b. a brief visual inspection was made of the foreshore, adjacent waterbodies and tributaries, and flood defences (where appropriate)

Receptor identification and sensitivity

14.4.16 The Thames RBMP divides the tidal Thames into three sections (or waterbodies) based on morphological and chemical characteristics, as follows:

a. Thames Upper – Teddington to Battersea Bridge (between 35 to 9km upstream of London Bridge)

b. Thames Middle – Battersea Bridge to Mucking Flats (between 9km upstream and 53km downstream of London Bridge)

c. Thames Lower – Mucking Flats to Southend (between 53km to 75 km downstream of London Bridge).

14.4.17 The three sections of the tidal Thames are shown in Vol 2 Figure 14.4.1 (see separate volume of figures).

14.4.18 Seven waterbodies classified under the WFD have been identified as relevant to the project as they are either adjacent to or downstream of the proposed development and therefore have the potential to be affected by it. A list of these waterbodies and their WFD status given in the RBMP is included in Vol 2 Table 14.4.1 below.

14.4.19 The current overall potential of each waterbody (the current ecological quality) is equal to the lowest class from any of the component parts making up the overall score. For each of the waterbodies which could potentially be affected by the proposed development, the worst scoring quality element ie, the component determining the current status, is given below in Vol 2 Table 14.4.1.

Vol 2 Table 14.4.1 Surface water – surface waterbodies status classified by WFD

Water body name/ID	Hydro-morphological status	Current ecological quality	Current chemical quality	Worst scoring quality element	2015 predicted ecological quality	2015 predicted chemical quality
Thames Upper GB530603911403	Heavily modified	Moderate potential	Good	Mitigation measures[iv] (moderate)	Moderate potential	Good
Thames Middle GB530603911402	Heavily modified	Moderate potential	Fail	Mitigation measures (moderate)	Moderate potential	Fail
Thames Lower GB530603911401	Heavily modified	Moderate potential	Fail	Invertebrates, dissolved inorganic nitrogen and mitigation measures (moderate)	Moderate potential	Fail
Beverley Brook (Motspur Park to Thames) and Pyl Brook at West Barnes GB106039022850	Heavily modified	Poor potential	Fail	Fish and macrophytes (poor)	Moderate potential	Fail
Wandle (Croydon to Wandsworth) and the R. Gravney GB106039023460	Heavily modified	Poor potential	Good	Fish and phytobenthos (poor)	Poor potential	Good
Regents Canal, lower Section, GB70610510	Artificial	Moderate potential	The RBMP states that this waterbody “Does not require	Mitigation measures (moderate)	Moderate potential	The RBMP states that this waterbody “Does not require

[iv] This refers to mitigation measures that have defined Ecological Potential, for example operational and structural changes to locks, sluices, weirs, beach control, etc and management of sediment.

Water body name/ID	Hydro-morphological status	Current ecological quality	Current chemical quality	Worst scoring quality element	2015 predicted ecological quality	2015 predicted chemical quality
			assessment”			assessment”
River Lee Navigation, tidal Section, GB70610068	Heavily modified	Moderate potential	The RBMP states that this waterbody “Does not require assessment”	Mitigation measures (moderate)	Moderate potential	The RBMP states that this waterbody “Does not require assessment”

14.4.20 The sensitivity of the receptors identified above has been established using the criteria given in Vol 2 Table 14.4.2 below.

Vol 2 Table 14.4.2 Surface water – assessment of importance of receptor

Receptor sensitivity	Criteria	Example
Very high	Water resource with an importance and rarity at an international level with limited potential for substitution	A water resource making up a vital component of a protected Special Area of Conservation (SAC) or Special Protection Area (SPA) A water body achieving a status/potential of high under the WFD
High	Water resource with a high quality and rarity at a national or regional level and limited potential for substitution	A water resource designated or directly linked to a Site of Special Scientific Interest (SSSI) A river designated as being of or having a target of good status/ potential under the WFD Water body identified as an EC designated Salmonid fishery
Medium	Water resource with a high quality and rarity at a local scale; or water resource with a medium quality and rarity at a regional or national scale	Water body classed as an EC designated Cyprinid fishery
Low	Water resource with a low quality and rarity at a local scale	A non 'main' river or stream or a waterbody without significant ecological habitat

Base case

14.4.21 The base case has been derived by the models described in Section 14.4 under desk based baseline data. The models predict both the current baseline conditions and the base case which includes both the sewage works upgrades and the Lee Tunnel.

14.4.22 A review of base case developments in the vicinity of the sites has been undertaken, using those schemes identified in the development schedules (See Appendix A.2 of Vol 3 and Appendix N of Vol 4 to 27). Developments that are considered likely to affect surface water resources (eg, any developments located within the tidal Thames) have been taken into account in the assessment.

14.5 Construction effects assessment

Assessment years

14.5.1 The assessment years for construction are Site Year 1 when construction would commence. Simulated model runs are only available for 2006, 2021 and 2080. Results from modelled simulations of conditions in 2021 without the Thames Tideway Tunnel project, but with the sewage works upgrades and the Lee Tunnel in place, have been used to establish the construction base case as no runs are available for construction Site Year 1 (2016 to 2017 for the majority of sites) at any site. This assumption is considered robust as substantial changes in water quality are considered unlikely to arise between 2016 and 2021. A delay to the Thames Tideway Tunnel project of approximately one year would not be likely to change materially the assessment findings reported in the assessments.

Assessment areas

14.5.2 The large dilution offered by the volume of combined tidal and freshwater flows in the Thames Tideway, enables the effects for each site assessment to be limited to those waterbodies local to the main tunnel sites. As explained in Section 14.2, the EA has provided advice on CSO excursion areas, this stated that CSOs below Tower Bridge would only impact the Thames Middle waterbody and those upriver of Tower Bridge would impact both the Thames Upper and Thames Middle waterbodies. This advice has been used to establish the assessment areas considered in each site-specific assessment within Vols 4 to 27.

14.5.3 When considering other discharges and abstractions in the vicinity of each site, a search area of 1km has been used.

Methodology

14.5.4 The methodology used for the assessment of effects on surface water resources differs from the standard Website Transport Analysis Guidance (WebTAG) (DFT, 2003)[14] methodology generally used for the assessment of water resources in EIA, in that the requirements of the WFD have also been taken into account.

14.5.5 In the absence of an EIA specific assessment methodology for WFD compliance, an assessment methodology has been derived specifically for the project to assess the significance of construction and operational effects using a combination of the EA's WFD assessment guidance and the Water Environment Sub Objective WebTAG Unit 3.3.11 methodology. This methodology has been developed to acknowledge that WFD objectives must be met for all waterbodies and to embed the principle that they all should be afforded the same protection against detrimental impacts, irrespective of the waterbody's current quality and importance as 'traditionally' defined by EIA water resource assessments.

Definition of WFD environmental objectives

14.5.6 The aim of the WFD is to achieve long-term sustainable water management based on a high level of protection of the aquatic environment. Environmental objectives are defined in Article 4 of the WFD. These objectives have been used for the assessment of all waterbodies, including those not being classified under the WFD.

14.5.7 The WFD environmental objectives for surface waters are presented in Vol 2 Table 14.5.1.

Vol 2 Table 14.5.1 Surface water – WFD environmental objectives

Objective	WFD reference article	Objective description
WFD1	4.1 (a) (i)	Prevent deterioration of the status of all bodies of surface water.
WFD2	4.1 (a) (ii)	Protect, enhance and restore all bodies of surface water, with the aim of achieving good surface water status by 2015.
WFD3	4.1 (a) (iii)	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.
WFD4	4.1 (a) (iv)	Reduce pollution from priority substances and cease or phase out emissions, discharges and losses of priority hazardous substances.

Identification of impacts and effects

14.5.8 For the purposes of this assessment, impacts and effects have been defined as follows:

a. Impact - a change in the physical attribute or hydrological regime of a surface waterbody eg, a change in water level.

b. Effect - the environmental consequence of the change in attribute, either in terms of compliance with relevant legislation or consequences for a user of that waterbody.

14.5.9 All potential impacts and their effects have been identified using the Source Pathway Receptor model (S-P-R), whereby the source of impact is identified, followed by the potential impact or pollution pathways and the likely surface water receptors. For each receptor identified, other users of the receptor (eg, abstractors) and the legislative requirements likely to be affected have also been identified in order to define the potential impact and resultant effect.

14.5.10 As described in Section 14.4, computational modelling scenarios have been used to predict future conditions and impacts. These models have been used to:

a. predict changes in pollutant loading to the tidal Thames from the capture and interception of CSO discharges at the location of discharge (site-specific)

b. predict project-wide (tidal Thames wide) beneficial impacts on water quality.

14.5.11 The modelled CSO predictions have then been used to infer changes in the discharge of sewage derived litter and pathogens as a result of the capture and interception of CSO discharges using simple calculations.

14.5.12 The impacts identified typically fall into two broad categories:

a. a change in water quality of a surface waterbody (due to e.g. CSO interception, surface water run-off or the mobilisation of potentially contaminated river sediments)

b. a change in morphology (physical form eg, cofferdam), leading to changes in flows (directions/velocities) with consequent changes in scour, accretion and sedimentation patterns.

14.5.13 Impacts considered within each of these categories could give rise to one or more of the following effects:

a. change in compliance with any of the WFD surface water objectives or other relevant legislation or policy

b. limitation on the use of water abstracted by third parties for which they are currently licensed

c. prevention or limitation on the use of, or the improvement in the conditions of a waterbody used by other users (eg, recreational users).

14.5.14 Where an effect is identified, it has been assessed for its significance as set out in the following section.

Significance criteria

14.5.15 The likely significant effects on surface water have been determined with reference to the guidelines published by the EA[15] and the Water Environment Sub-Objective WebTAG Unit 3.3.11[16]. As explained in para. 14.5.5, the methodology used has been developed specifically for this assessment and does not necessarily follow the general methodology for assessing significance (combination of impact magnitude and receptor sensitivity) described in Section 3 General EIA methodology.

14.5.16 Where likely significant effects have been identified, their significance has been assessed following the criteria provided in Vol 2 Table 14.5.2.

Vol 2 Table 14.5.2 Surface water – significance criteria

Significance of effect	Description
Major adverse	The effects would prevent objective WFD1 being met, resulting in a deterioration of waterbody status; or would prevent objectives WFD2 and WFD3 being met resulting in a waterbody being prevented from achieving the minimum required status of ‘good’ (or ‘good potential’); or would prevent compliance with other legislation.
Moderate	Effects would not affect long term status of a waterbody under the WFD; but the effects of the project may be

Significance of effect	Description
adverse	judged to be important at a local scale and could limit the use of a waterbody for eg, licensed abstraction or recreation, or prevent WFD4 from being achieved.
Minor adverse	Deterioration in a waterbody attribute is expected, but it would not prevent or limit other users of the waterbody (recreational users, abstractors or dischargers) nor prevent compliance with legislation, water quality standards or policy.
Negligible	A change is in waterbody attribute is likely to arise, but it is unlikely to be detectable (or measurable) in relation to the expected natural variance.
Minor beneficial	An improvement in a waterbody attribute is expected, but it would not allow additional use of the waterbody (recreational users, abstractors or dischargers) nor ensure compliance with legislation, water quality standards or policy
Moderate beneficial	Beneficial effects of the project are unlikely to move a waterbody to a higher status but may be judged to be important at a local scale (ie, in the local planning context).
Major beneficial	Beneficial effects of the project would allow the requirements of the UWWTD or other legislative targets to be met; or, are likely to result in ‘good status/potential’ being achieved; or, would allow future attainment of good status in combination with improvements undertaken elsewhere.

14.5.17 Effects determined to be either major or moderate are considered to be significant for the purposes of this *Environmental Statement*.

14.5.18 It is possible that impacts deemed not to result in a significant effect in relation to surface water resources may have a significant effect on aquatic ecology receptors. Where this is potentially the case, the impact and potential effect has been described and reference made to Section 5 Ecology – aquatic in Vol 4 - 27.

14.6 Operational effects assessment

Assessment years

14.6.1 The base case assessment year for the assessment of surface water operational effects is Year 1 of operation (2023). As with the construction base case, the operational base case also relies on modelled water quality data which uses population projections for 2021 (Scenario 2). A delay to the Thames Tideway Tunnel project of approximately one year would not be likely to change materially the assessment findings reported in the assessments.

14.6.2 The assessment year for the operational development case is the first year of the Thames Tideway Tunnel project operation (Scenario 3).

Additional assessment years: climate change

14.6.3 In order to account for the anticipated impacts of climate change, the surface water assessment has also undertaken an assessment of 2080. To describe the 2080 base case without the Thames Tideway Tunnel project, a simulation has been used that includes predicted 2080 conditions including population estimates and assumes the Lee Tunnel and proposed sewage works upgrades are in place (Scenario 4). The base case for this assessment year has been based on the predicted changes in river temperature and river flow that may arise by 2080 as a result of the latest United Kingdom Climate Projections (UKCP09)[17] issued by the UK Climate Impact Programme (UKCIP).

14.6.4 Changes in catchment rainfall, river temperatures and river flow by 2080 are predicted to have an effect on the water quality conditions of the tidal Thames. The catchment models and QUESTS estuary model have been run for predicted 2080 environmental conditions and population estimates in order to assess the future performance of the Thames Tideway Tunnel project (Scenario 5).

Assessment areas

14.6.5 The assessment areas for the assessment of operational effects for the site assessments are the same as for the assessment of construction effects.

Methodology

14.6.6 The methodology for the assessment of operational effects is the same as that followed for the assessment of construction effects.

Significance criteria

14.6.7 The significance criteria used for the assessment of operational effects is the same as that followed for the assessment of construction effects.

14.7 Cumulative effects assessment

14.7.1 The general approach to assessing cumulative effects is described in Section 3 of this volume. The specific approach for surface water is described below. The assessment years considered for the cumulative effects assessment remain as defined in Section 14.5 and 14.6 above. The assessment areas considered for the cumulative effects assessment also remain as defined above.

14.7.2 The cumulative assessment considers the effects on surface water receptors identified in Section 14.4 from construction and operation of the Thames Tideway Tunnel project in conjunction with other relevant developments likely to be under construction or operation at the same time. A qualitative assessment of the cumulative effects is presented in each site-specific volume.

14.8 Project-wide effects assessment

14.8.1 The general approach to assessing the likely significant effects, including project-wide effects, is described in Section 3. The specific approach for assessing project-wide surface water effects is described below.

Assessment years

14.8.2 The assessment years for the project-wide assessment are the same as those considered for the site-specific assessments.

Assessment areas

14.8.3 The project-wide surface water assessment covers the assessment of the significance of effects that would accrue to the tidal Thames as a whole as a result of the project.

Methodology

14.8.4 As explained in Section 14.4 the effects of the project on the water quality has been defined by modelled DO levels using the QUESTS WQM. Improvements to DO

14.8.5 The DO thresholds for the tidal Thames were initially defined in 2005 through the TTSS (Thames Water, 2005)[18] and these have been subsequently refined through ongoing modelling work to support the development of the Thames Tideway Tunnel project. The final thresholds developed are shown in Vol 2 Table 14.8.1 below.

Vol 2 Table 14.8.1 Surface water – DO thresholds set for the tidal Thames

Threshold	Dissolved oxygen (mg/l)	Return period (years)	Duration (tides)
1	4	1	29
2	3	3	3
3	2	5	1
4	1.5	10	1

Note – the objectives apply to any continuous length of river >3km. Duration means that the DO must not fall below the limit for more than the stated number of tides. A tide is a single ebb or flood. Compliance has been assessed using the network of AQMS stations.

14.8.6 An explanation of thresholds is provided below:

a. Threshold 1 - the DO level in the tidal Thames must not fall below 4mg/l for longer than 29 consecutive tides (approximately equal to one week) on more than one occasion per year.

b. Threshold 2 - the DO level in the tidal Thames must not fall below 3mg/l for longer than 3 consecutive tides on more than one occasion every 3 years.

c. Threshold 3 - the DO level in the tidal Thames must not fall below 2mg/l for longer than 1 tide on more than one occasion every 5 years.

d. Threshold 4 - the DO level in the tidal Thames must not fall below 1.5mg/l for longer than 1 tide on more than one occasion every 10 years.

14.8.7 For all scenarios tested (Section 14.4), the biggest summer rainfall events (over 100 in total) over a period of 41 years were modelled and each scenario subsequently tested for compliance against the DO thresholds to determine whether they had been exceeded and for how long. When all 41 years of data are considered, the return periods for each DO threshold give rise to an ‘allowable’ number of times when the threshold can be exceeded, as follows:

a. Threshold 1 has a return period of once a year, which means that tidal Thames can fall below 4mg/l for longer than 29 consecutive tides only once in each year; over 41 years of modelled data this results in an allowable number of 41 times when this DO threshold can be exceeded before the standard is failed.

b. Threshold 2 has a return period of once every 3 years, which means that tidal Thames can fall below 3mg/l for longer than 3 consecutive tides only once every 3 years; over 41 years of modelled data this results in an allowable number of 13 times when this DO threshold can be exceeded before the standard is failed.

c. Threshold 3 has a return period of once every 5 years, which means that tidal Thames can fall below 2mg/l for longer than 1 consecutive tide only once every 5 years; over 41 years of modelled data this results in an allowable number of 8 times when this DO threshold can be exceeded before the standard is failed.

d. Threshold 4 has a return period of once every 10 years, which means that tidal Thames can fall below 1.5mg/l for longer than 1 consecutive tide only once every 10 years; over 41 years of modelled data this results in an allowable number of 4 time when this DO threshold can be exceeded before the standard is failed.

14.8.8 As well as the full suite of 41 years of modelled rainfall events, the WQM has also been used to simulate a full year of time series analysis with daily rainfall inputs used in the model. The 41 year dataset has been analysed to select the single year which was most representative of an observed Typical Year of rainfall. The 1980 water year has been selected for this purpose.

14.8.9 The WQM was used to test the performance of the proposed project against the objectives and ‘allowable’ number of times when the thresholds can be exceeded as defined above.

14.8.10 The significance criteria outlined in Section 14.5 has been used to assess the significance of the effects from the operation of the Thames Tideway Tunnel project.

Project-wide cumulative effects

Construction

14.8.1 A qualitative assessment has been undertaken to identify the project-wide cumulative effects on surface water receptors identified in Section 14.4. The assessment considers effects that could arise from construction of the Thames Tideway Tunnel project in conjunction with other relevant developments likely to be under construction or operation at the same time. The projects considered in the project-wide assessment are primarily large scale infrastructure projects.

Operation

14.8.2 As with the construction the cumulative assessment for project wide, considers effects that could arise from operation of the Thames Tideway Tunnel project in conjunction with other relevant developments likely to be under construction or operation at the same time.

14.9 Assumptions and limitations

14.9.1 This section details general assumptions and limitations associated with the surface water assessment. Site-specific assumptions and limitations are detailed in Vols 4 to 27 (Section 14 Water resources – surface).

Assumptions

14.9.2 In addition to the use of the QUESTS WQM, the EA's AQMS and spot sampling results have been used to determine the baseline water quality. It has been assumed that the AQMS network gives accurate results, although it should be noted that the AQMS network is an operational one, designed to help the EA manage the tidal Thames and that the data is not designed specifically for environmental assessment. However the AQMS network gives the longest continuous data record available, and therefore it has been judged to be suitable for use within this assessment.

14.9.3 As explained in Section 14.5, simulated model runs are only available for 2006, 2021 and 2080. Results from modelled simulations of conditions in 2021 without the Thames Tideway Tunnel project, but with the sewage works upgrades and the Lee Tunnel in place, have therefore been used to establish the construction base case as no runs are available for Site Year 1 of construction (2016 to 2017 for the majority of sites) at any site. This assumption is considered acceptable as substantial changes in water quality are considered unlikely to arise between 2016 and 2021.

14.9.4 Where a proportion of the dredged material could be lost to the water column (para 14.4.12), the assessment assumes a 5% loss of material from the proposed backhoe dredging method. For the assessment of sediment mobilisation It has been assumed that there is an in situ density of 2t per m^3 (para 14.4.12).

Limitations

14.9.5 As discussed above, the AQMS network is an operational one, designed to help the EA manage the tidal Thames. The locations of the AQMS monitoring points are concentrated in the stretches of the tidal Thames where the key water quality effects of STW and CSO discharges are observed ie, to the west near Mogden and to the east near Beckton, Abbey Mills, Crossness, Longreach and Riverside STWs. There is therefore no AQMS data available for the stretch of the tidal Thames between Cadogan Pier and the Thames Barrier. For the main tunnel sites within this stretch of the river, the assessment of baseline water quality has been based on EA spot samples taken between 2005 and 2009.

14.9.6 Definition of tidal Thames conditions and CSO operation during the base cases and development cases are reliant on model simulations. Model simulations have degrees of error that must be considered. In particular, the WQM was designed specifically to allow a comparative assessment of solutions and future conditions and does not provide an exact prediction of the future conditions. It does however allow an accurate assessment of relative differences between scenarios and is considered by the EA to be ‘fit for purpose’ as determined during the production of the TTSS and as reported in the *Needs report*.

14.9.7 The assessment of the beneficial effect of a reduction in sewage derived litter and pathogens discharged to the tidal Thames has been inferred from catchment modelling results of the reduction in discharge volume, frequency and duration and has not been directly modelled.

14.10 Mitigation

Construction

14.10.1 The Thames Tideway Tunnel project has been designed to minimise environmental effects and therefore the construction design/methods take account of surface water considerations including measures within the *CoCP*. Where such measures form part of the project, they are identified in Volume 1 (for the tunnel itself) and Section 3 of Vols 4 to 27 (for each site) and have been considered as embedded measures within the assessment.

14.10.2 Where the assessment indicates significant adverse effects having taken account of embedded measures, mitigation has been identified as appropriate.

Operation

14.10.3 The Thames Tideway Tunnel project has been designed to minimise environmental effects and therefore the design takes account of surface water considerations including surface water runoff and any changes to flow patterns due to in-river structures. Where such measures form part of the project, they are identified in Vol 1 (for the tunnel) and Section 3 of Vols 4 to 27 (for each site) and have been considered as embedded environmental design within the assessment.

14.10.4 Where the assessment indicates significant adverse effects, having taken account of embedded environmental design, mitigation has been identified as appropriate.

14.11 Residual effects assessment

14.11.1 Where mitigation measures are proposed, residual effects are assessed by following the same methodology and significance criteria described above.

14.11.2 Where no mitigation measures are proposed, the residual effects remain as identified through the relevant assessment (construction, operation or project-wide).

References

[1] The Council Directive 91/271/EEC concerning urban waste-water treatment.

[2] The Urban Waste Water Treatment (England and Wales) Regulations 1994.

[3] Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy.

[4] The Water Environment (Water Framework Directive) (England and Wales) Regulations 2003.

[5] Environment Agency, *River Basin Management Plan,* Thames River Basin District, 2009.

[6] National Policy Statement for Waste Water – *A framework document for planning decisions on nationally significant waste water infrastructure*, Defra, 2011.

[7] Environment Agency, *Assessing shoreline management plans against the requirements of the Water Framework Directive* (2009).

[8] Web-based *Transport Analysis Guidance* (WebTAG) (2003). Available at: http://www.dft.gov.uk/webtag/documents/overview/unit1.2.php.

[9] *The* United Kingdom Technical Advisory Group (UKTAG) to the WFD, http://www.wfduk.org/.

[10] Environment Agency (2009). See citation above.

[11] Environment Agency (2009). See citation above.

[12] *Automatic Quality Monitoring Station (AQMS) and spot sample water quality data for the Tidal Thames*, EA, unpublished data via personal communication, 10th March 2011.

[13] Thames Water. *Thames Tideway Strategic Study* (February 2005).

[14] WebTAG (2003). See citation above.

[15] Environment Agency (2009). See citation above.

[16] WebTAG (2003) See citation above.

[17] UK Climate Change Projections, *UK Climate Impact Programme 2010,* http://ukclimateprojections.defra.gov.uk/.

[18] Thames Water (2005). See citation above.

This page is intentionally blank

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Environmental Statement

Doc Ref: **6.2.02**

Volume 2: Environmental assessment methodology

Section 15: Water resources - flood risk

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

Hard copy available in

Box **16** Folder **A**
January 2013

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

This page is intentionally blank

Thames Tideway Tunnel

Environmental Statement

Volume 2: Environmental assessment methodology

Section 15: Water resources – flood risk

List of contents

List of tables

15 Water resources – flood risk

15.1 Introduction

15.1.1 This section sets out the methodology for the assessment of flood risk associated with the Thames Tideway Tunnel project.

15.1.2 A project-wide Flood Risk Assessment (FRA) has been prepared in accordance with the requirements of the *National Policy Statement for Waste Water* (*NPS*) (Defra, 2012)[1] to assess the effects of construction and operation, at all sites within the project and across the tidal Thames. This project-wide assessment (see Volume 3 Project-wide assessment) is consistent with the requirements of the *NPS* and the outputs and findings of the Thames Estuary 2100 (TE2100) (EA, 2012)[2] study and the policy requirements of the *London Plan 2011* (GLA, 2011)[3] and the *Mayor's Water Strategy* (GLA, 2011)[4].

15.1.3 In addition to the project-wide assessment, an assessment of flood risk has been made at each site and is included within the site-specific volumes of the *Environmental Statement*. All relevant available information on flood risk has been collected and used to inform the design of individual sites as well as the level of detailed flood risk assessment required.

15.1.4 The *NPS* process tools and the results of an initial screening exercise, has been used to further develop each site-specific flood risk assessment into an FRA in accordance with guidance set out in the *NPS*.

15.1.5 The initial screening exercise outlined a level approach to FRAs, which defined the FRA depending on the level of detail required to satisfy policy requirements. However policy has been superseded since the screening exercise and the NPS does not advocate a level approach so all reference to a Level 1, Level 2 or Level 3 FRA have been removed from the FRA methodology.

15.1.6 Each site-specific FRA has been used to assess potential flood risk both to and from the development. Design measures to reduce any elevated risks are outlined within each site assessment volume (Volumes 4-27).

15.1.7 The scope of each FRA is to identify:

a. the baseline conditions against which the project should be assessed

b. the risk of flooding arising to the proposed development in addition to the risk of flooding from the development

c. the vulnerability of the site and users to flooding from all sources

d. the need for design measures, which would be used to counteract any identified significant adverse effects

e. the remaining 'residual' flood risk after design measures have been taken into account.

15.1.8 The effects on flood risk have been considered in two ways:

a. the effects of the Thames Tideway Tunnel project on overall flood risk within the River Thames (see Vol 3)

b. the effects of the proposed construction and operation of each of the construction sites in relation to flood risk from all sources, within and in the immediate vicinity of each site.

15.1.9 Where flood risk is related to other environmental considerations such as surface water quality and groundwater, these relationships have been explored within the specific assessments such as surface water or ground water. Consequently, the flood risk assessments should be read in conjunction with other sections such as groundwater and surface water, as discussed within this volume in Section 13 Water resources – groundwater and Section 14 Water resources – surface water.

15.2 Engagement

15.2.1 The general approach adopted regarding engagement is summarised in Section 2 of this volume.

15.2.2 A summary of scoping and technical engagement undertaken in relation to flood risk is contained in Vol 2 Appendix M.1.

15.2.3 A Technical Working Group (TWG) on flood risk was established with the EA. The TWG has been used to discuss the approach to the FRAs and modelling studies undertaken to assess the Thames Tideway Tunnel project in respect to flood risk.

15.2.4 A *Flood Risk Scoping Report* was prepared as part of the scoping stage of the environmental impact assessment (EIA). The purpose of the report was to outline the proposed approach to the flood risk work to accompany the application for development consent (the application). The *Flood Risk Scoping Report* was issued to the EA and the local authorities (LPAs) for comment in March 2011. Comments were received from April 2011 onwards and where relevant they have been addressed in this methodology. Overall the EA supported the approach taken in the *Flood Risk Scoping Report* and their response is included in Vol 2 Appendix M.2.

15.2.5 In addition to the specific *Flood Risk Scoping Report*, an EIA *Scoping Report* was also issued to relevant consultees including the EA and LPAs. The EA commented that the FRAs should be included within the EIA scoping assessment and environmental assessment. The EA comments were reiterated by a number of LPAs in their EIA scoping opinions. In response to these comments the FRAs have been integrated into the EIA report. The Infrastructure Planning Commission (IPC) did not comment on flood risk issues in their response to the EIA *Scoping Report*.

15.2.6 A draft FRA was provided to the EA for their comment and agreement as part of the ongoing consultation process. Consultation responses from the EA are contained within Vol 2 Appendix M.2.

15.2.7 Engagement with the LPAs has taken place in the form of a flood risk forum held in June 2011, where the project (site-specific and as a whole) was discussed specifically in relation to flood risk. This included discussion of the *Flood Risk Scoping Report*. The majority of the LPAs and the EA were in attendance at this forum.

15.2.8 Vol 2 Appendix M.1 outlines the comments with respect to flood risk from the relevant consultees and explains how the appropriate changes have been incorporated within the methodology. The table contains both methodological and site specific comments as the site assessments do not have a separate section on engagement. Vol 2 Appendix M.1 does not repeat the comments summarised above.

15.3 Legislation and guidance

National Policy Statement for Waste Water

15.3.1 The relevant planning document that would be used to assess the project is the *NPS for Waste Water* (Defra, 2012)[5] which was published in February 2012.

15.3.2 The *NPS* considers the Thames Tideway Tunnel project as 'essential waste water infrastructure'.

15.3.3 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.

Sequential Test

15.3.4 The *NPS* aims to ensure that flood risk is taken into account at all stages of the planning process, directing 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.

15.3.5 An extensive site selection process, including consideration of the flood risk at each site, has been followed to identify sites to be included within the proposals. Where combined sewer overflows (CSOs) require interception, the location of possible sites and interceptions has normally been limited to sites in close proximity to the CSOs and therefore most have tended to be close to (or on) the foreshore. As a consequence of the CSO interception requirement, most CSO sites (and some of the viable alternatives) would lie within Flood Zone 3b. Furthermore, the main tunnel alignment along the course of the River Thames, as well as the commitment to use a high proportion of barging for export of excavated materials, requires that most main tunnel sites are also located close to or on the foreshore. As with the CSO sites, this means that most of the main tunnel sites (and most viable alternatives) are located within Flood Zone 3a and 3b. Further detail regarding alternative sites is included in Volume 1 Introduction to the Environmental Statement Section 3.

15.3.6 The site selection process outlined in Vol 1 Section 3 demonstrates a sequential approach and completion of the Sequential Test at site selection stage as required in the *NPS*. More detail on the project level Sequential Test is detailed in Vol 3.

15.3.7 A sequential approach has been applied at site level to minimise the risk of flooding by directing the more vulnerable uses to the lowest areas of flood risk.

Exception Test

15.3.8 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.

15.3.9 The requirements of the Exception Test are provided 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). The project level Exception Test is detailed in Vol 3.

15.3.10 Vol 2 Table 15.3.1 presents the requirements within the NPS relevant to flood risk and explains how the requirements have been addressed within the *Environmental Statement*. The table also gives the location of the relevant material.

Vol 2 Table 15.3.1 Flood risk – requirements of the NPS and how they have been addressed

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
The applicant should take account of policy on climate change adaption.	The TE 2100project has been considered in the FRA methodology. All water levels assessed in the hydraulic models for the River Thames and associated tributaries have included an allowance for climate change. When determining potential attenuation storage for SuDS schemes an allowance of climate change has been made in the rainfall calculations.	Full details of the *Project wide* FRA and individual FRAs are provided in Vol 3 - Section 15 and Vol 4-27 - Section 15. Vol 2 - Sections 15.4 and 15.6.
The **applicant** should provide a flood risk assessment for projects of 1 hectare or greater in Flood Zone 1, and all proposals for projects	A project-wide FRA has been prepared to assess the effects of construction and operation, at all sites within the project and across the tidal Thames. In addition to the project-wide assessment, a site-specific FRA has been undertaken	Full details of the *Project wide* FRA and individual FRAs are provided in Vol 3 - Section 15 and Vol 4-27- Section 15.

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
located in Flood Zone 2 and 3. This should identify and assess the risks of all forms of flooding to and from the project and demonstrate how these flood risks will be managed, taking climate change into account. The **decision maker** should be satisfied that the application is supported by an appropriate FRA.	for each site and is included within the site-specific volumes of the Environmental Statement. All relevant available information on flood risk has been collated and used to inform the design of individual sites as well as the level of detailed flood risk assessment required. The requirements for an FRA defined by the NPS have been used to determine the appropriate methodology for both the project-wide FRA and site specific FRA.	
The applicant should arrange pre-application discussions with the Environment Agency, and where relevant other statutory bodies.	Consultation with the Environment Agency has been ongoing from the initial stages of the project and this included the establishment of a Technical Working Group on flood risk. As part of on-going consultation, other statutory bodies such as the PLA and local councils have been kept informed of changes to the project and asked for comments at various stages of the projects development such as the scoping stage, Section 48 and site specific developments such as flood compensation discussions with the London Borough of Wandsworth for King Georges Park.	Full details are available in Section 15.2.
The **decision maker** should be satisfied that the Sequential Test has been applied as part of the site selection; and that a sequential approach has been applied at the site level to minimise risk by directing most vulnerable uses to areas of lowest flood	Where combined sewage overflows (CSOs) require interception, the location of possible sites and interceptions has normally been limited to sites in close proximity to the CSOs and therefore most have tended to be close to (or on) the foreshore where the CSO is located. As part of the site selection process for the project, a review was undertaken for all site options	Full details are provided in the project wide FRA in Vol 3 - Section 15.

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
risk.	with respect to Flood Zone, standard of flood defence and SuDS suitability and used to assess the implications of flooding to each site option. This information was used in the overall decision making process on the final site selection decisions. Therefore the Sequential Test has been completed as part of the site selection process and the project is considered to pass the Sequential Test.	
The **decision maker** should be satisfied that the Exception Test has been undertaken for sites located in flood zone 3.	Consideration of parts a) with respect to sustainability, part b) with respect to the site selection process and part c) of the Exception Test with respect to completing an FRA and not increasing flood risk have been assessed in the project-wide FRA and demonstrate that the project is considered to pass the Exception Test.	Full details are provided in the project-wide FRA in Vol 3 - Section 15.
The **decision maker** should be satisfied that the proposal is in line with any relevant national and local flood risk management strategy.	The FRA methodology takes into account the NPS and NPPF as well as local flood risk policies such as the TE2100 project, London Plan and local authority Strategic Flood Risk Assessment and Surface Water Management Plan reports.	Full details of relevant policies are provided in the *Project wide* FRA and individual FRAs within Vol 3 - Section 15 and Vol 4-27 - Section 15.
The **decision maker** should be satisfied that priority has been given to the use of SuDS and the requirements of the National Standards have been met.	The Environment Agency has agreed that operational sites on or adjacent to the foreshore should discharge directly to the tidal Thames as no attenuation occurs in the current situation as identified in their letter dated 9th February 2012. For other sites, the site specific FRAs detail the SuDS approach that is proposed on each site and estimate the residual storage	*Design Principles* report (Section 3). See Vol 1 Appendix B)

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
	volumes that would need to be attenuated, typically by underground storage, to achieve the London Plan essential standard. Any proposed drainage systems would be designed to comply with the *National Standards for SuDS* (Defra, 2011)[6].	
The decision maker should be satisfied that in flood risk areas, the project is appropriately flood resilient and resistant, including safe access and escape routes where required and that any residual risk can be safely managed over the lifetime of the development.	The Thames Tideway Tunnel project commitment is to maintain the existing standard of flood defence at all sites during construction and operational periods. The *Code of Construction Practice (CoCP)* details safe access/egress requirements during the construction period for sites located in the floodplain. The project does not need to remain operational in the event of a flood. The Project wide FRA includes details of the operational use of the sites and how this manages residual risk across the project and demonstrates that the project would be resilient to flooding as: • Any loss of local functions (eg, power, automatic control and system monitoring functions) would not compromise the long term operation of the tunnel as flow into the tunnel could be controlled, if required, by manual operation of actuated penstocks while electro mechanical systems are serviced or replaced. It is envisaged that most of the affected plant could be serviced or replaced and returned to automatic	Full details are provided in the Project wide FRA and individual FRAs within Vol 3 - Section 15 and Vol 4-27 - Section 15. Full details of the construction staff guidance relating to flood risk can be found in the *COCP* Part A (Section 4 and 8). The *CoCP* is provided in Vol 1 Appendix A. It contains general requirements (Part A), and site specific requirements (Part B). Full details are provided in the Project wide FRA within Vol 3, Section 15.

Requirements of the NPS	How the requirement is addressed	Location of where to find further detail
	operation within a few weeks of the flood subsiding. • Flooding of the tunnel itself would not create conditions dissimilar to those under which the tunnel is designed to operate and would not compromise the long term operation of the tunnel.	

National Planning Policy Framework

15.3.11 The relevant planning policy document of reference for undertaking an FRA is the *National Planning Policy Framework* (Communities and Local Government, 2012)[7] (*NPPF*), which was published in March 2012. Section 10 of the *NPPF* and the *Technical Guidance to the NPPF* (Communities and Local Government, 2012)[8] detail the requirements of flood risk assessments.

15.3.12 The *NPPF* outlines the Flood Zone classifications and details regarding the approach for FRAs. The Flood Zones are defined in Vol 2 Table 15.3.2.

Vol 2 Table 15.3.2 Flood risk – flood zones

Flood zone	Definition
Flood Zone 1- low probability	This zone comprises land assessed as having a less than 1 in 1000 annual probability of river or sea flooding (<0.1%).
Flood Zone 2- medium probability	This zone comprises land assessed as having between a 1 in 100 and 1 in 1000 annual probability of river flooding (1%-0.1%), or between a 1 in 200 and 1 in 1000 annual probability of sea flooding (0.5%-0.1%) in any year.
Flood Zone 3a- high probability	This zone comprises land assessed as having a 1 in 100 or greater annual probability of river flooding (>1%), or a 1 in 200 or greater annual probability of flooding from the sea (>0.5%) in any year.
Flood Zone 3b- functional floodplain	This zone comprises land where water has to flow or be stored in times of flood.

Based on technical guidance to the NPPF table 1

The London Plan 2011

15.3.13 The *London Plan 2011* (GLA, 2011)[9] provides detail with regard to the requirement of new development to demonstrate a reduction in surface water runoff in the associated *Mayors Water Strategy* (GLA, 2011). The *London Plan Sustainable Design and Construction Supplementary Planning Guidance* (2009) (GLA, 2006)[10] sets out 'essential' and 'preferred' standards (outlined in the *London Plan 2011*) as detailed in 3.

Vol 2 Table 15.3.3 Flood risk – London Plan 2011 surface water runoff standards

Essential standard	Preferred standard
Use SuDS measures, wherever practical.	Achieve 100% attenuation of the undeveloped site's surface water runoff at peak times to greenfield runoff rates.
Achieve 50% attenuation of the undeveloped site's surface water runoff at peak times.	

15.3.14 The *London Plan 2011* Policy 5.13 sustainable drainage (GLA, 2011)[11] promotes the use of SuDS ,encourages developers to aim to achieve greenfield runoff rates and details the drainage hierarchy that should be followed to ensure that surface water runoff is managed as close to its source as possible.

The Drain London Surface Water Management Plans

15.3.15 The *London Regional Flood Risk Appraisal* (*RFRA*) (GLA, 2009)[12] was published in October 2009, providing a number of recommendations to help address strategic issues relating to flood risk in London. One of the key conclusions of the appraisal was that the threat of surface water flooding in London was poorly understood.

15.3.16 As a result of the *RFRA* and triggered by the damages caused by surface water flooding during the 2007 summer floods, Defra funded the Drain London Project (GLA, 2011)[13], which included the development of SWMPs for each London borough.

15.3.17 The aim of the Drain London Project (GLA, 2011)[14] was to help the Greater London Authority (GLA) and Lead Local Flood Authorities (LLFAs)[i] (introduced by the Flood and Water Management Act[15]) manage and reduce surface water flood risk in London by improving knowledge of the surface water drainage system and identifying areas at greatest risk of flooding.

15.3.18 Each SWMP used pluvial modelling (described below) to identify critical drainage areas. These are areas of significant flood risk, characterised by the amount of surface runoff that drains into the area, the topography and hydraulic conditions of the pathway (eg, sewer, river system), and the receptors (people, properties and infrastructure) that may be affected.

15.3.19 Within each area 2-Dimensional pluvial modelling (using TuFLOW software) was undertaken following a direct rainfall approach. This approach is where rainfall events of known probability were applied directly to the ground surface and water was routed overland to provide an

[i] The Flood and Water Management Act defines the LLFA for an area as the Unitary or the County Council.

indication of potential flow path directions, velocities and areas where surface water is likely to pond.

15.3.20 The site assessments for the Thames Tideway Tunnel project take account of the conclusions and recommendations of the relevant Drain London Project SWMPs, where these have been made available for the assessment. See further details in Section 15.4.

Strategic Flood Risk Assessments

15.3.21 A SFRA is intended to provide a strategic assessment of flood risk across LPAs in order to support Local Plans and flooding policies. The aim of a SFRA is to direct development away from areas of high risk of flooding using the sequential approach.

15.3.22 SFRAs have been completed for all of the relevant LPAs and are available in the public domain.

15.3.23 The site assessments for the Thames Tideway Tunnel project take account of the conclusions and recommendations of the relevant SFRAs. See further details in Section 15.4.

Thames Estuary 2100

15.3.24 The Thames Estuary 2100 (TE2100)[16] project was established in 2002 with the aim of developing a long term tidal flood risk management plan for London and the Thames Estuary. It was led by the Environment Agency and sets out the strategic direction for managing for managing flood risk in discrete policy areas across the estuary and contains recommendations on actions needed in the short, medium and long term.

15.3.25 The TE2100 implementation plan was published in November 2012 and identifies future flood defence levels that should be taken into consideration for the design of new flood defences.

15.4 Baseline data collection

15.4.1 The baseline data used in the FRA assessments is desk based and no field survey data has been obtained.

Desk based baseline data

15.4.2 Data to support the formulation of a baseline has been collected from the following main sources:

a. observed data including historical flooding data eg, Thames Water DG5 records, sewer flooding data and local authority flood records

b. hydrodynamic modelling of the tidal Thames and small sections of tributaries eg, River Wandle

c. secondary research from supporting studies including SFRAs, SWMPs and the TE2100 study.

15.4.3 All third party data types and sources used in the flood risk assessments are outlined in Vol 2 Table 15.4.1.

Vol 2 Table 15.4.1 Flood risk – desk based baseline third party data sources

Source	Data	Notes
EA	Data relating to all main rivers relevant to the project including the River Thames, Beverley Brook, River Wandle, River Lee, River Roding and River Ravensbourne/Deptford Creek.	Flood depth (node levels and depth grids) for all return periods including functional floodplain information.
	Flood defence information throughout the assessment area.	Flood defence standards, required defence standards, National Flood and Coastal Defence Database (NFCDD), proposed flood defence improvements.
	EA Flood Zone information.	Flood Zone outlines for all modelled return periods.
	Historical flooding records.	
Local planning authorities	SFRAs, SWMP from Drain London outputs.	SFRAs were all available in the public domain. SWMP from Drain London were obtained with permission.

15.4.4 Studies that were completed as part of the Thames Tideway Tunnel project and used in this assessment include:

a. River Wandle modelling (see Volume 8 Dormay Street and Volume 9 King George's Park Appendix M).

b. 2D hydraulic modelling of the River Thames (HR Wallingford) to assess the overall impact of the Thames Tideway Tunnel project on tide levels and flood storage associated with the River Thames (HR Wallingford, 2011)[17].

c. Black & Veatch, *Scour Interpretative Report* (Vol.3, Appendix L3) that summarise the scour studies undertaken to assess the impact of the proposed development on scour.

Drain London Surface Water Management Plans

15.4.5 The following SWMPs have been provided by the relevant LLFAs for use within this assessment:

a. City of London (GLA, 2011)[18]

b. City of Westminster (GLA, 2011)[19]

c. Royal Borough of Kensington and Chelsea (GLA, 2011)[20]

d. LB of Ealing (GLA, 2011)[21]

e. LB of Lambeth (GLA, 2011)[22]

f. LB of Lewisham (GLA, 2011)[23]

g. LB of Newham (GLA, 2011)[24]

h. LB of Richmond upon Thames (GLA, 2011)[25]

i. LB of Southwark (GLA, 2011)[26]

j. LB of Tower Hamlets (GLA, 2011)[27]

k. LB of Wandsworth (GLA, 2011)[28]

15.4.6 The SWMP reports for the LB of Hounslow, Hammersmith and Fulham and Royal Borough of Greenwich have not been made available for use in this assessment.

Strategic Flood Risk Assessments

15.4.7 The following SFRAs have been used to inform the flood risk to each site:

a. LB of Ealing (Capita Symonds Ltd, 2008)[29]

b. LB of Hammersmith & Fulham and RB of Kensington & Chelsea (JBA Consulting, 2010)[30]

c. RB of Greenwich (JBA Consulting, 2011)[31]

d. LB of Richmond upon Thames Level 1 (Jacobs Ltd, 2008)[32]

e. City of Westminster (Westminster City Council, 2010)[33]

f. City of London (Mouchel Parkman, 2007)[34]

g. LB of Lewisham Level 1 (Jacobs, 2008)[35]

h. LB of Newham (Capita Symonds Ltd, 2010)[36]

i. LB of Lambeth Level 1[37] and Level 2[38] (Scott Wilson Ltd, 2008).

j. LB of Southwark (London Borough of Southwark, 2008)[39]

k. LB of Wandsworth, Merton, Sutton and Croydon Level 1(Scott Wilson Ltd, 2008)[40] and Level 2 (Scott Wilson Ltd, 2009)[41]

l. LB of Tower Hamlets Level 2 (Capita Symonds, 2012)[42].

Fluvial and tidal data

15.4.8 Hydraulic models enable the estimation of flood extents and flood depths based on detailed topographic data of river channels including structures (bridges, culverts etc), flood defences and surrounding floodplain land. The flood extents are compiled using rigorously developed statistically derived flow estimates. Hydraulic models have been developed for a number of watercourses within the project area by the EA. Those used to inform the FRAs for the Thames Tideway Tunnel project are described below.

River Thames EA hydraulic model

15.4.9 The Tidal Thames Joint Probability Extreme Water Levels 2008 modelling assessment (EA, 2008)[43] makes use of a 2-D joint-probability hydraulic model. The joint-probability aspect of the model considers the confluence of different factors such as astronomical tides, tide surge and river flows. This has been provided by the EA in the form of model node locations and water levels (the peak water levels during a modelled extreme event). In summary, the calculation of extreme water levels in the model involved two main stages:

a. estimating a matrix of water levels at various locations (or model nodes) along the tidal Thames

b. calculating the statistical frequency (probabilities) with which a particular water level might be expected to occur at each of the model nodes.

15.4.10 The study modelled water levels to various annual exceedance probabilities (AEP)s, including 10%, 5%, 2%, 1%, 0.5%, 0.2% and 0.1%. Each of these probabilities were modelled with and without the Thames Barrier in place, for present day (2005) and future years (2055 and 2107) taking into account Defra's climate change allowances as set out in Table 5 of the Technical Guidance to the *NPPF*.

15.4.11 The model takes into account the Thames Barrier closure rule[ii] and assumes that it remains unchanged up to 2107. However, predicted increases in sea levels and fresh water flow mean that the Thames Barrier closure rule condition would be met more often. In the model, the highest tides experienced upstream of the Thames Barrier occur when the circumstances are within a fine margin of meeting the closure rule and the decision is taken not to close (a near closure event).

15.4.12 This model has been used within the Thames Tideway Tunnel project FRAs to provide the extreme water levels for each site assessment to assess the standard of flood defence and level of tidal risk to a site.

15.4.13 In 2011, HR Wallingford (HR Wallingford, 2011) undertook flow modelling and simulations of river conditions to assess the cumulative impacts of the proposed Thames Tideway Tunnel project structures on tidal propagation and peak water levels.

15.4.14 The EA River Thames model has been refined by HR Wallingford to include the proposed structures in order to show the overall impact of the works.

15.4.15 The updated 2011 model has also been run for the scenario with the Thames Barrier absent to investigate the water levels in the Thames Tideway in the absence of this flow control structure.

[ii] The Thames Barrier operation is based on the exceedence of combinations of high water levels at Southend-on-Sea and fluvial flows measured at Kingston. The decision to close the barrier is however human so closures are often carried out at lower levels than specified.

15.4.16 The EA requested that additional modelling of high fluvial flows at Teddington with the barrier be undertaken. This scenario has been included within the Thames Tideway HR Wallingford model.

15.4.17 A wide range of return periods were modelled in the Thames Tideway HR Wallingford model and this has been used to inform the project-wide assessment.

15.4.18 A potential loss of storage within the River Thames associated with the foreshore sites was assessed in this model and has been summarised in each site assessment with respect to tidal and fluvial risk from the developments. This is covered in more detail within Vol 3.

Beverley Brook EA hydraulic model

15.4.19 The Beverley Brook and tributaries were modelled in 2008 by Royal Haskoning for the EA's *Beverley Brook Flood Risk Mapping Study* (Royal Haskoning, 2009)[44]. The methodology involved the use of ISIS-TUFLOW (10m grid) (1D-2D linked modelling) software. The outputs of the modelling were produced to improve flood warning and planning, flood defence planning and maintenance, to upgrade the EA flood maps and for development planning purposes.

15.4.20 The main outfall of the Beverley Brook into the River Thames is via Ashlone Wharf tidal flap gates. There are also two flood relief culverts: White Hart Lane and Elm Bank, which drain the Beverley Brook into the Thames. These discharges are influenced by tidal conditions on the River Thames.

15.4.21 The 1D-2D linked model was built using a mean high water spring tide curve as the downstream boundary condition and using the rainfall-runoff approach of the *Flood Estimation Handbook* (FEH) (Centre for Ecology and Hydrology, 1999)[45] to determine the sub-catchment inflow hydrographs.

15.4.22 The model provides flood outlines, water level, flow, velocity and depth data and details on areas benefiting from flood defences for the 20%, 5%, 1%, 1% + 20% for climate change including flood defences, and the 1% AEP undefended event (0.1% AEP event was unstable). The model simulates fluvial flooding only, other contributions such as groundwater or surface water were not included.

15.4.23 This model has been used by the Thames Tideway Tunnel project to inform the Barn Elms FRA and specifically to determine the fluvial flood risk associated with the Beverley Brook on the Barn Elms site.

River Wandle EA hydraulic model

15.4.24 A modelling study of the River Wandle was carried out by Halcrow Group Limited to inform the EA *River Wandle 2D Flood Modelling and Mapping Study* (Halcrow Group Limited, 2010)[46]. This was undertaken to improve flood mapping and inform emergency planning, development control and flood warning within the catchment.

15.4.25 As part of the work completed by Halcrow Group Limited, an ISIS-TUFLOW model was developed, linking the 1D channel to the 2D floodplain.

15.4.26 The model hydrology (Flood fReQuency SIMulation method [FRQSIM]) was updated by the EA where necessary to make the method more robust and a tidal peak of 4mAOD which coincides with the fluvial peak has been used as a downstream model boundary.

15.4.27 The model has been run as part of the EA *River Wandle Flood Modelling and Mapping Study* for the 20%, 5%, 2%, 1%, 1% + 20% for climate change, and 0.1% AEP events including flood defences, and the 1% and 0.1% AEP events for the undefended scenario. Flood map outlines, peak water levels and flows, grid data for flood depths, velocities and hazards, and areas benefiting from defences were produced by Halcrow Group Limited/EA from the above outputs. The model simulates fluvial flooding only. Other contributions such as groundwater or surface water have not been included.

15.4.28 As part of the Thames Tideway Tunnel project sections of the River Wandle EA hydraulic model have been updated in order to undertake the FRAs at King George's Park and Dormay Street. This has been completed following liaison with the EA and a technical note describing additional modelling is included within the Appendix M of Vol 8 and Vol 9.

River Lee hydraulic model

15.4.29 The River Lee was modelled as part of the Lower Lee Valley SFRA (Capita Symonds, 2005)[47] using the *Environmental Statement* TRY TUFLOW Model (1D – 2D linked hydrodynamic model) from Lea Bridge Road to its confluence with the River Thames.

15.4.30 The TUFLOW model represents the whole floodplain within 2D domains, providing an accurate representation of the flood behaviour. The topography of the 2D domain was based on data from a LiDAR ground survey, and the channel is represented through a series of 1D cross sections and structures.

15.4.31 The model was run by Capita Symonds as part of the Lower Lee Valley SFRA for the 1% fluvial + 5% tidal, 1% fluvial (+ 20% climate change) + 5% tidal and 0.1% fluvial + 5% tidal AEP defended events. Results of the flood depth and extent were generated. The model simulates fluvial flooding only and does not consider other contributions such as surface water or groundwater.

15.4.32 The results of the River Lee modelling have been used to inform the Abbey Mills Pumping Station FRA with respect to fluvial flood risk.

Lower River Roding hydraulic model

15.4.33 Flood extents for the Lower River Roding have been generated through a 1D-2D linked model produced for the EA (Capita Symonds, 2009)[48].

15.4.34 The model was run by Capita Symonds for the 20% 10%, 5%, 1%, 1% +20% for climate change, 0.5% and 0.1% AEP events with flood defences present. The model was also run for 0.1% AEP without flood defences present. Flood depth and extent outputs were created.

15.4.35 The Lower River Roding model outputs have been used by the Thames Tideway Tunnel project to inform the FRA at Beckton Sewage Treatment Works.

River Ravensbourne/Deptford Creek hydraulic model

15.4.36 In 2008/2009 Halcrow Group Limited undertook a review of previous flood risk mapping work carried out in 2006 on the River Ravensbourne (Halcrow Group Limited, 2009)[49]. Following this, changes were made to the existing hydraulic model by the EA and a final modelling report was completed in 2010 (Halcrow Group Limited, 2010)[50]. This included culvert asset surveys, manhole surveys and topographic surveys of additional/reclassified tributaries to supplement the previous modelling work. The result of the survey work were used to inform remodelling of the River Ravensbourne and its major tributaries using two linked ISIS-TUFLOW models (one of the Ravensbourne and tributaries and one of the Quaggy and tributaries). The TUFLOW model grid was set to 6m.

15.4.37 Improvements made to the 2006 model included revised hydrology and improved representation of flooding through surcharging manholes and subsequent overland flow routes.

15.4.38 Outputs included flood levels, flows and extents for the defended catchment scenario. Following this, hazard maps were created by the EA using depth and velocity outputs (both with and without a debris factor) from the model.

15.4.39 The models were run for the 10%, 5%, 2%, 1% and 1% + 20% for climate change AEP events. The model results showed differences between 2006 and 2008/9 due to the inclusion of the 2D element of the model. This difference has been identified as a general increase in modelled flood extents. Events in the order of 1% AEP would result in widespread flooding within the catchment.

15.4.40 The model has been used within the FRA at the Greenwich Pumping Station to determine the fluvial risk associated with this flood source.

Flood defence data

National Flood and Coastal Defence Database

15.4.41 Flood defence data have been supplied by the EA for the majority of sites in the form of National Flood and Coastal Defence Database (NFCDD) (EA, 2011)[51]. These contain spatial information on the location of each flood defence, asset type and description, maintainer, design standard and length. The EA also provided the statutory flood defence level and survey data containing information on defence crest heights and condition of defence along with the NFCDD data.

15.4.42 The statutory flood defence level is set by the Environment Agency as the minimum level for a flood defence crest height to ensure protection to a specified standard. The actual surveyed crest levels of the flood defence may vary from the statutory level as the flood defences are in a range of ownership from private, riparian owners to local authority and Environment Agency therefore they relate to independent structures built at different times and in most cases these pre-date when the statutory flood defence levels were originally set out.

15.4.43 Condition information is collated by the EA to monitor the flood defences and to inform its maintenance works. There are five condition grades ranging from 'very good' to 'very poor'. A summary of the grades and conditions they represent is provided below:

a. Grade 1 – very good
b. Grade 2 – good
c. Grade 3 – fair
d. Grade 4 – poor
e. Grade 5 – very poor.

River wall assessment

15.4.44 It is possible that tunnelling and other construction methods could lead to the settlement of river walls and flood defences (as well as other buildings and structures). 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.

15.4.45 In view of the uncertainty inherent in the settlement predictions, the proposed approach to settlement mitigation is a 'monitor and mitigate' approach. Under this approach, 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.

Flood zone maps

15.4.46 Flood zone maps from the EA (EA, 2012)[52] have been used to inform flood risk at each site. These have been compiled by the EA from the most up to date hydraulic modelling results available. They show the estimated extent of Flood Zone 2 (area between the 0.1% and 1% AEP of flooding) and Flood Zone 3 (area with an AEP of greater than or equal to 1% fluvial flood risk or 0.5% tidal flood risk). The flood zone maps represent the combination of the fluvial and tidal flood zones along the River Thames and assume the absence of flood defences, but do show where these are present and areas which benefit from local defences.

15.4.47 The flood zone maps give a good indication of the areas at risk of flooding in the assessment area, but they do not provide detail on individual properties, or information on flood depth, velocity or volume of flow. They also do not map possible flooding from other sources, such as groundwater, direct runoff, or overflowing sewers.

Scour assessment

15.4.48 The Thames Tideway Tunnel project would include a number of temporary and permanent works located within the River Thames itself. A scour summary report (Black and Veatch, 2012) has been undertaken to determine the potential magnitude of scour of the riverbed associated with the works. The sites that were included in the assessment were:

a. Putney Embankment Foreshore
b. Albert Embankment Foreshore
c. Chelsea Embankment Foreshore
d. Kirtling Street
e. Heathwall
f. Blackfriars Bridge Foreshore
g. King Edward Memorial Park Foreshore
h. Chambers Wharf
i. Victoria Embankment Foreshore
j. Carnwarth Road

15.4.49 At each of these sites, potential scour has been assessed for operation and construction using currently available data including bed grab samples, detailed bathymetry survey, design layouts and available flow modelling.

Construction

15.4.50 Results from the scour summary report have been used to inform the Scour Monitoring and Mitigation Strategy (see Vol 3 Appendix L.4) for temporary works in the foreshore. In view of the limited scour predicted at most sites and the uncertainty over the predictions, the proposed approach to scour during construction outlined in the Plan is a ‘monitor and mitigate’ approach. Under this approach, any potential scour development during construction would be monitored and protective measures would only be provided when an appropriate trigger level is reached. This approach would limit the scour protection to areas where it is required and thus help minimise encroachment on l habitats and help maintain existing channel profiles.

Operation

15.4.51 Results from the scour summary report have been used to inform the approach for permanent works in the foreshore. The approach to scour protection for the permanent works sites is outlined in the *Engineering Design Report* and the areas for the potential extent of scour protection for permanent works is outlined on the parameter plans for each foreshore site. In contrast to the approach taken during construction and given the design life of the development, a proactive approach has been defined which specifies scour protection as part of the design for the permanent works.

15.4.52 The effect of the permanent works on scour at third party structures would be monitored for a one year period in a similar way to that defined for the construction phase. Given that the permanent works are smaller than the temporary works it is unlikely that further scour effects would be identified, which have not manifested themselves during the construction phase. However in the event that the monitoring identifies a need for new or additional protective works to an existing structure, these works would be agreed with the owner of the structure and the relevant consents obtained as necessary.

Topographic data

15.4.53 Topographic data for the project are in the form of survey data covering the majority of each site. This has been used to identify potential surface water flow paths both across the site and in the near vicinity of the site.

15.4.54 Light Detection and Ranging (LiDAR) digital terrain model data provided for the purposes of the River Wandle modelling study have a 0.5m resolution (see Appendix M of Vol 8 and Vol 9).

Surface water flood risk data

15.4.55 To determine the potential surface water flood risk to each site an assessment has been made of potential flow paths using the topographic information, and considering existing modelling information from the Drain London SWMP reports as well as records of flooding from the SFRAs.

15.5 Assessment methodology

Overview

15.5.1 The methodology used for the assessment of effects on flood risk and its significance differs slightly from the general EIA methodology described in Section 3 of this volume. Typically, the likely significance of an effect is determined by assessing the magnitude of an impact against the vulnerability or sensitivity of a receptor. However, due to the nature of flood risk assessments, the risk based approach outlined in the *NPPF* is considered preferable. 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. Notwithstanding the risk based approach, it is still possible to identify a substantive change in flood risk as a significant effect. This approach has been used within the FRA conclusions for each site.

15.5.2 The aim of an FRA is to assess the risk of all forms of flooding to and from a development. The FRAs undertaken for the Thames Tideway Tunnel project assess the effects of construction and operation for the lifetime of the project (taking into consideration climate change) on the relevant watercourses, for both project-wide effects and at the site-specific scale. *NPPF* emphasises the need for a risk-based approach, which can be applied through the application of the source-pathway-receptor model. This is the approach used for the FRAs within this *Environmental Statement*.

15.5.3 The source-pathway-receptor model first identifies the causes or ‘sources’ of flooding to and from a development. The identification is based on a review of local conditions and consideration of the effects of climate change. The nature and likely extent of flooding arising from any one source is considered, eg, whether such flooding is likely to be localised or widespread.

15.5.4 The presence of a flood source does not always infer a risk. It is the exposure pathway or the 'flooding mechanism' that determines the risk to the receptor and the effective consequence of exposure. For example, the presence of a sewer does not necessarily increase the risk of flooding unless the sewer is local to the site and ground levels encourage sewage to accumulate. The identification of flooding pathways has been undertaken by considering the site and surrounding topography, the proximity of the flood source to the receptor and the potential flood conveyance routes local to the site.

15.5.5 If a flooding mechanism is not apparent, then the risk from the flood source is considered to be negligible. If a flood source and flooding pathway have been identified, the assessment of the flood risk to the receptor has been determined by combining the likelihood of the flood event occurring with the severity of the effect (consequences) if the flood event were to occur.

15.5.6 The varying effect of flooding on receptors depends largely on their flood risk vulnerability as defined by the *NPPF* (Table 14.3.2). Receptors include areas within the range of the flood source which are connected to the source of flooding by a pathway.

15.5.7 In order for there to be a flood risk, all the elements of the model (a flood source, a pathway and a receptor) must be present. Measures to reduce flood risk can often be provided by removing, diverting or reducing the impact of one element of the model, for example by removing the pathway or receptor.

15.5.8 Where modelled assessment data have been available to inform the project-wide and site-specific FRAs, they have been used to define the probability of a flood event occurring, thereby providing a quantification of likelihood. However, for some sources of flooding (eg, groundwater) the probability or likelihood of flooding occurring cannot be fully quantified using existing information and a qualitative assessment has been undertaken based on expert judgement and available information and records.

15.5.9 In summary, the flood risk at each site and on a project-wide basis has been determined by considering:

a. the types of flood source

b. the flood mechanisms identified (pathways)

c. the location and sensitivities of possible receptors.

Spatial scope

15.5.10 The spatial scope considered for flood risk is the immediate site area. However consideration is given to the proximity to local watercourses and flow paths to the site from the surrounding area.

15.5.11 Site specific FRAs have been prepared for all of the sites. The project wide assessment has been completed to assess the cumulative impacts of the project on flood risk.

Temporal scope

Current baseline

15.5.12 The current baseline is the current flood risk of the sites from the potential flood sources specific to each site. The current flood risk at each site is considered to be unchanged between 2012 and 2016 as flood defence and water levels are not considered to vary significantly in this time and represent the base case.

Assessment years: construction

15.5.13 Each FRA considers flood risk during the whole construction period over varying timeframes according to the length of construction required for the Thames Tideway Tunnel project as a whole and at each individual site.

15.5.14 The construction effects assessment has considered the possibility that the construction programme could be delayed by up to a year. However, flood defence and water levels would be considered unchanged within this timeframe and as such, the findings of the assessment as a result of a change in programme are not anticipated to vary materially from those for the proposed assessment year.

Assessment years: operation

15.5.15 Each FRA considers flood risk during operation of the Thames Tideway Tunnel project from 2023.

Additional assessment years: climate change

15.5.16 Each site has also been assessed in the operational phase with the timeframe of 100 years into the future (from 2011) to assess potential impacts of climate change for the project.

15.5.17 The base case for this assessment year has been based on the predicted changes in rainfall, river flows and sea levels that may arise by 2111, as detailed in the *Technical Guidance to the NPPF (Tables 4 & 5).*

15.6 Flood sources

15.6.1 The *NPS* requires the effects of all forms of flood risk to and from the development to be considered within an FRA. Forms of flooding include those from tidal, fluvial, surface water, groundwater, sewers and artificial sources and these are reviewed as below.

Tidal flood risk

15.6.2 Most of London is adequately defended from tidal flooding by the Thames Tidal Defence (TTD) network. Therefore the risk of tidal flooding is a residual risk, defined as the risk that remains after flood avoidance and alleviation measures have been put in place.

15.6.3 For the purposes of the FRAs, the baseline risk of flooding from the sea has been assessed using *NPPF* defined flood zones as described in the water levels estimated from the Tidal Thames Joint Probability Extreme Water Levels 2008 modelling assessment (EA, 2008)[53]. These are outlined in Vol 2 Table 15.6.1.

15.6.4 Given the presence of the TTD, the two mechanisms which could lead to a flood event are a breach of the defences or overtopping of the defences and these are discussed below.

Breach

15.6.5 A localised breach/failure of the floodwalls can occur in situations where a defence is present with a crest raised above adjacent land levels. Failure could occur under a number of scenarios, eg, collision of river traffic, other collision/demolition action including potential settlement to the flood defences, scouring of the defences when overtopped and/or hydrostatic water pressure during high tides (breaches are more likely during extreme tides or periods of high river flow when loads on the defence would be greater).

15.6.6 Other potential causes of a breach or defence failure include development works adjacent to flood defences such as excavations, and structural failure as a result of the defences coming to the end of their design life.

15.6.7 If a localised breach or defence failure was to occur along the River Thames, it is unlikely that appropriate warning time would be available for evacuation due to the sudden and unexpected nature of the event.

15.6.8 A flood defence failure could, if it coincided with a high water level, result in high velocities and volumes of flood water flowing through the breach and into low lying areas which could result in significant disruption and damage. The time taken for a breach to be repaired can have a major effect on the extent and depth of flooding experienced.

15.6.9 In the unlikely event of a failure in the flood defences upstream of the Thames Barrier, it is likely that the Barrier would be closed to enable the breached defences to be repaired, reducing the potential volume of water that could flow through a breach and allowing emergency services to evacuate areas affected.

15.6.10 It is not possible to accurately quantify the risk of a breach in tidal defences. However, for the purposes of the FRAs, reference to data including the following has been made (see Vol 2 Table 15.4.1 for further detail):

a. historic flood levels and flood extents as a result of breaches

b. EA flood defence condition surveys

c. flood defence level

d. ground level behind defences

e. topography

f. relevant SFRA site specific breach model results (where available)

Overtopping

15.6.11 Overtopping for the purpose of this project refers to the event when a still water level is higher than a defence crest height, and so water would spill over the defence. Flood defences could also be overtopped if the Thames Barrier failed to close and a storm surge travelled up the estuary into central London.

15.6.12 As sea levels rise over time, the Thames Barrier would have to close with increasing frequency, and not just in response to surge tides. With operational constraints limiting the number of closures in any one year, the risk of overtopping would increase.

15.6.13 Flood defences are usually designed with a degree of ‘freeboard’, the height by which the crest level of the defence exceeds the design flood level. Defences along the River Thames are maintained at approximately the 0.1% AEP standard and are designed to have freeboard above their design level (the crest height of these defences are therefore above the 0.1% AEP water level), although the freeboard varies depending on the location.

Fluvial flood risk

15.6.14 Section 15.7 explains that a fluvial flood event on the River Thames would result in lower water levels than a tidal event. Therefore the greatest risk posed by the River Thames is considered to be tidal flood risk.

15.6.15 There are however a number of other rivers which require consideration as part of the site-specific FRAs.

a. River Ravensbourne/Deptford Creek

b. River Wandle

c. River Roding

d. River Lee

e. Beverley Brook.

15.6.16 For the purposes of the FRAs, the baseline risk of flooding from fluvial sources has been assessed using *NPPF* defined fluvial flood zones as described in Vol 2 Table 15.3.2 and flood mapping outputs provided by the EA (unless more updated information is available in the form of FRA modelling to demonstrate local flood zone variations). These classifications are outlined in Vol 2 Table 15.6.1.

Vol 2 Table 15.6.1 Flood risk – fluvial and tidal sources criteria

Flood Zone Classification (*NPPF*)	Flood Risk term used for fluvial and/or tidal sources (the presence of defences is not taken into consideration as per the *NPPF*)
Flood Zone 1	Low
Flood Zone 2	Medium
Flood Zone 3a	High

Flood Zone Classification (*NPPF*)	Flood Risk term used for fluvial and/or tidal sources (the presence of defences is not taken into consideration as per the *NPPF*)
Flood Zone 3b	Very High

15.6.17 It should be noted that foreshore sites are part of the active floodplain of the River Thames and subject to daily tidal inundation. The sites are therefore considered as functional floodplain and classified as Flood Zone 3b. Due to the undefended nature of the floodplain at such locations and the frequency at which tidal inundation occurs, the 'risk of flooding' to those sites is considered to be very high.

Surface water flood risk

15.6.18 Surface water originates when rain water cannot infiltrate into the ground, due to the conversion of land to an impermeable surface or due to the intensity of the storm, antecedent conditions or underlying geological conditions. Rain water can pond on the ground surface and travel via overland flow under gravity to low areas, usually the local river or surface water network. Surface water flooding can occur at locations where surface water flow paths converge, at local dips in the ground and/or due to overland obstructions or when it is unable to enter the already surcharged sewer system.

15.6.19 The risk of flooding from overland flow has been determined by a review of local topographical data, local drainage assets and reference to surface water modelling undertaken as part of the SWMPs where these were available. Where the SWMPs were not available, reference to the EAs Flood Map for Surface Water (FMfSW) which provides an indicative map on the risk from surface water flooding, and has been made to assess the potential for surface water flooding at the approximate site location. A greater weighting has been used for the identified flood depth to determine the risk of flooding from surface water as this is considered up to date and reflective of the surrounding catchment area and flow paths. The flood risk is defined in Vol 2 Table 15.6.2.

Vol 2 Table 15.6.2 Flood risk – flooding from land criteria

Local topography	SWMP/ FMfSW identified flood depth	And/or local drainage assets	Risk of flooding from surface water
Steep topography, or site located at topographical high, or site not located within a critical drainage area	<0.25	No known capacity restrictions serving site and surrounding area.	Low

Local topography	SWMP/ FMfSW identified flood depth	And/or local drainage assets	Risk of flooding from surface water
Moderate local topographic slopes	0.25-0.5	Local drainage present but potential capacity restrictions.	Medium
Shallow graded topography, or site located at topographical low, or is within a critical drainage area	>0.5m	No local drainage assets	High

Approach to surface water management

15.6.20 The approach within this assessment is to:

a. Determine the general requirements for runoff attenuation from the proposed development by identifying the existing site uses and determining the likely development changes (eg, extent of hard standing proposed, this was determined from landscape drawings and would be subject to change for final site landscape designs).

b. Identify measures for the management and disposal of surface water runoff from the development, sufficient to achieve the Mayor's Essential Standard.

15.6.21 Given the parameter plan approach, it has not been possible to undertake precise surface water attenuation calculations of the development for which consent is sought. However, the parameter plans are based on a series of draft operational layouts, which do not form part of the application but for which it has been possible to determine a likely approximate change in impermeable area. These figures have then been used to calculate an approximate attenuation requirement, which provides context to the identification of appropriate SuDS techniques and any requirement for residual storage.

15.6.22 The implementation of SuDS techniques has been considered at each site. Details of SuDS measures that could be applied at each site are provided within the site assessments. Where possible a direct discharge into the tidal Thames has been the preferred disposal method.

15.6.23 The SuDS techniques that have been proposed in the site assessments, take into account the EA's SuDS hierarchy, together with site location, ground conditions and topography. In general, where SuDS techniques are unlikely to be sufficient to provide the required attenuation, the balance would be delivered by underground storage.

15.6.24 Sustainable approaches to surface water drainage include:

a. prevention (good site design and housekeeping to prevent runoff and pollution): rainwater harvesting and reuse

b. source control (managing runoff at or very near the source): rainwater harvesting, recycling and drainage, green roofs, porous paving

c. site control (managing the risk within the site): infiltration, eg, soakaways, filter strips and swales, filter drains and porous pavement, ponds

d. regional control (managing the risk from several sites): infiltration, eg, communal facilities, basins and wetlands.

15.6.25 The EA has a proposed a SuDS hierarchy within the South East Region as detailed in Vol 2 Table 15.6.3.

Vol 2 Table 15.6.3 Flood risk – EA SuDS hierarchy

SuDS feature	Rank
Living/Green Roofs	1
Constructed Wetlands/Retention Pond	2
Detention Basins	3
Filter strips and Swales	4
Soakaways	5
Infiltration Trenches	6
Gravelled Areas	7
Porous Paving	8
Over-sized pipes	9
Storage Tanks/Cells	10

15.6.26 As outlined in the *NPS* any proposed drainage systems would need to comply with the National Standards for SuDS (Defra, 2011)[54] which were released in draft for consultation in December 2011.

15.6.27 The suitability of infiltration SuDS[iii] measures at relevant sites has been determined through information provided in the SWMPs (infiltration SuDS suitability figures). A range of suitabilities have been determined based on the SuDS Manual (2007) (CIRIA, 2007)[55] classification of soil types and infiltration SuDS. Where sites are located within, or immediately adjacent to the foreshore, no storage volumes are provided as it is assumed that direct discharge to the River Thames without attenuation would be achievable. This is considered to be an appropriate approach given that any precipitation falling on foreshore sites currently lands directly within the River Thames, and the discharge of runoff therefore occurs instantaneously, and with no attenuation. The flood risk reduction benefits of any surface water attenuation provision on foreshore sites would therefore be minimal given the location at the downstream extent of the

[iii] Infiltration SuDS are those which enable water to drain directly into the ground

catchment, immediately adjacent to the discharge point to the tidal Thames.

15.6.28 For sites inland where direct discharge into the tidal Thames is not possible, outline storage volumes have been calculated for the 1% AEP plus climate change event using the following methodology.

15.6.29 For undeveloped ‘greenfield’ sites the 1% AEP surface water runoff rate has been calculated using the Interim Code of Practice for SuDS[56] rural runoff method using the Micro Drainage WinDes® Version 12.5 software. This method is recommended for sites < 50 ha. Soil infiltration coefficients ranging from 0.15 (sandy, well drained) to 0.5 (steep, rocky areas) have been estimated using soil and geological information.

15.6.30 For previously developed sites the 1% AEP surface water runoff rate from hardstanding areas has been calculated using the Modified Rational Method. The equation for the Modified Rational Method is provided below:

$$Q = Cv \times Cr \times (2.78 \times i \times A)$$

Where:

Q = Runoff rate (l/s)

Cv = Volumetric runoff coefficient, typically 0.75

Cr = Routing factor of 1.3

i = Rainfall intensity (based on rainfall profile derived from FEH CD-ROMv3 catchment descriptors)

A = Area of impermeable land (ha).

15.6.31 For sites consisting of undeveloped ‘greenfield’ areas and previously developed impermeable areas the 1% AEP surface water runoff rate have been calculated for each area using the appropriate runoff rate method. The two runoff rates are then added together to provide an overall 1% AEP runoff rate for the site.

15.6.32 Based on the permanent works proposed at each site the 1% AEP post development runoff rate (without mitigation) has been calculated based on the impermeable area proposed at the site. In accordance with the NPPF recommendations the post development surface water runoff rate includes a 30% increase in peak rainfall intensity to account for the anticipated impact of climate change over the development’s lifetime.

15.6.33 Preliminary storage volume calculations have been undertaken using Micro Drainage WinDes® Version 12.5 software to ensure that, after the development has been carried out, the surface water runoff rates for each site comply with the requirements of relevant planning policy. At this stage all attenuation volumes are based on zero infiltration, as no infiltration rate information is currently available at the sites.

15.6.34 To take into account the effects of climate change over the developments lifetime, a 30% increase in peak rainfall intensity has been included when considering post development runoff and the associated attenuation volumes. This information has been provided as a storage estimate in cubic meters for sites where surface water attenuation would be required (eg not sites where discharge is proposed un-attenuated into the tidal Thames).

Groundwater flood risk

15.6.35 Groundwater flooding arises when the water table meets the ground surface, leading to the presence of groundwater at the surface. Water tables may be perched or in hydraulic conductivity with local watercourses. Many water courses are derived from the last mechanism.

15.6.36 A quantitative assessment of potential flood risk from groundwater has been undertaken in each FRA through reference to existing groundwater information at each site. Groundwater flood risk is defined in Vol 2 Table 15.6.4 where information exists on groundwater levels at the site and is a function of groundwater level (in meters below ground (mbg)), potential groundwater pathways and the permeability of the overall site geology. A separate table (Vol 2 Table 15.6.5) has been used to determine groundwater flood risk in the absence of groundwater level data at the site or in the immediate vicinity.

Vol 2 Table 15.6.4 Flood risk – groundwater flood risk criteria with groundwater level data

Depth of groundwater (mbg)	And/or pathways	And/or geology	Risk of groundwater flooding
>1	No pathway as confined.	Impermeable layers such as clay present above the groundwater level.	No risk
>1	Pathways present as unconfined.	Mixture of potential gravels and sands.	Low
<1	Pathways present.	If no record of groundwater flooding or borehole information.	Medium
<1	Potential connectivity to watercourses and/or site ground level, pathways present.	And records of groundwater flooding.	High

Vol 2 Table 15.6.5 Flood risk – groundwater flood risk criteria where no groundwater level

Pathways	Geology	SFRA	Risk of groundwater flooding
Unlikely	Impermeable	No records	Low
Possible	Permeable	No records	Medium
Likely	Permeable	1+ record	High

Sewers flood risk

15.6.37 Sewers flooding arises when the capacity of the local sewer network is exceeded or a problem arises such as a blockage or fracture.

15.6.38 Exceedence occurs when the quantity and/or rate of water entering the network exceeds the capacity of the system to receive, hold or transmit that quantity or rate. This can occur during short intense or prolonged steady rainfall events and in extreme circumstances can lead to the surcharging of water (and diluted sewage in the case of combined systems) to the ground surface through manholes and gullies.

15.6.39 Drainage systems are typically constructed to accommodate storm events with an AEP of 3.3% or more. An assessment of the risk of flooding from sewers has been made through reference to Thames Water sewer network plans in conjunction with data on local topography and records of sewer flood history. This has allowed the identification of areas where capacity may be problematic during short intense or steady prolonged rainfall events.

15.6.40 Within the assessment area there are four types of sewer that are designed to convey different types and quantities of wastewater and surface water. These are identified as:

a. Foul water sewers which drain foul water to the sewage treatment works.

b. Surface water sewers which drain surface water that has entered the sewer system from gullies. These do not convey foul water.

c. Combined sewers which carry foul water flow during dry weather conditions. During rainfall events, these sewers also drain surface water runoff.

d. CSOs are the overflow sewers from a combined sewer that discharges waste and surface water to an outflow point when the capacity of the combined sewer is reached. These typically have a large capacity and allow some backing up of wastewater within the system prior to spilling.

15.6.41 The risk of sewer flooding is greatest from combined sewers and surface water sewers as these are designed to receive water from rainfall events. These sewers are therefore more susceptible to exceedence during high intensity rainfall events. Foul water sewers pose less of a risk during rainfall events as they are not typically connected to rainwater collection systems (gullies etc) and are therefore not influenced by rainfall events. CSOs are designed to detain large volumes of sewage prior to discharge via a controlled and designed route and so pose a low risk of flooding.

15.6.42 A pathway is required in order to create a risk from this source of flooding. Sewer flooding pathways can be present through the sewer network and the surface topography (once sewers have surcharged and sewage is at ground level). Vol 2 Table 15.6.6 details the assessment criteria used to determine the risk to the site and surrounding development from sewer flooding. The criteria are based on the type of sewer, proximity to the site and potential pathway. A higher weighting has been given to the number of historic records of sewer flooding within 200m of the site provided by Thames Water.

Vol 2 Table 15.6.6 Flood risk – sewer flood risk criteria

Proximity to local sewer network* and pathways	And/or sewer flood history for within 200m of the site	Risk of sewer flooding
Sewer network >20m from site and no likely pathways to site	No records	Low
Sewer network within 20m of site and restricted pathways to site	1-5 records	Medium
Sewer network crosses site and pathways exist to the site	5+ records	High

** Sewer network implies it is not a CSO system*

15.6.43 During the construction of the main tunnel, the existing sewer system would operate as normal. Only at the time when connections are made to the tunnel would the risk of sewer flooding potentially temporarily increase due to the interception of the existing system and this is considered within the assessment as appropriate.

Artificial sources of flood risk

15.6.44 Artificial flood sources include raised channels such as canals or storage features such as ponds and reservoirs.

15.6.45 An assessment of risk of flooding from artificial sources has been made through reference to EA reservoir inundation mapping and information contained within SFRAs. The criteria for flood risk from artificial sources are detailed in Vol 2 Table 15.6.7.

Vol 2 Table 15.6.7 Flood risk – artificial sources flood risk criteria

Proximity to artificial flood source in km (canals, raised storage, reservoirs)	And/or EA reservoir inundation mapping	Risk of flooding from artificial sources
>5	Not within EA risk area	Not applicable

Proximity to artificial flood source in km (canals, raised storage, reservoirs)	And/or EA reservoir inundation mapping	Risk of flooding from artificial sources
	or located topographically upstream of flood source. No pathway.	
1-5	Restricted pathway to the site.	Low
1 – 5	Pathway exists to the site.	Medium
<1	Within EA risk area or topographically downstream of flood source.	High

15.7 Assumptions and limitations

15.7.1 This section details general assumptions and limitations associated with the assessment of flood risk. Site-specific assumptions and limitations are detailed in Vol 4-27 Section 15 Water resources – flood risk.

15.7.2 Assumptions and limitations relevant to the FRAs are outlined below:

a. It is assumed all data provided by the EA are the most up to date and relevant to the project.

b. It is assumed the Thames Barrier would be closed; therefore extreme water level events such as the 1 in 200 year event have not been assessed as they would be unable to propagate upstream.

c. It is assumed the topographic data used in the flood risk assessments to determine potential flow paths accurately represents the ground levels at each site.

d. It is considered that a fluvial flood event on the River Thames with a return period of 1% AEP would result in lower water levels on the River Thames than those experienced during an extreme tidal flood event with the same return period. Therefore, the greatest risk posed by the River Thames is a combined tidal flood and fluvial flood risk as demonstrated by the Tidal Thames Joint Probability Extreme Water Levels 2008 (EA, 2008)[57] modelling assessment.

e. Given the parameter plan approach, it has not been possible to undertake precise surface water attenuation calculations of the development for which consent is sought. However, the parameter plans are based on a series of draft operational layouts, which do not form part of the application but for which it has been possible to determine a likely approximate change in impermeable area. These figures have then been used to calculate an approximate attenuation requirement, which provides context to the identification of appropriate SuDS techniques and any requirement for residual storage

15.7.3 The use of each SWMPs was made available by the relevant LPA. The SWMP reports for the LB of Hammersmith and Fulham and Royal Borough of Greenwich have not been made available for use in this assessment.

15.7.4 Despite the above assumptions and limitations, the assessment is considered to be robust.

15.8 Mitigation

15.8.1 The Thames Tideway Tunnel project has been designed to minimise environmental effects and the construction design/methods take account of flood risk considerations including measures identified within the *CoCP* (Section 8). Where such measures form part of the project, they are identified in Vol 1 (for the tunnel itself) and Section 3 of Vol 4-27 (for each site) and have been considered as embedded measures within the assessment.

15.8.2 The majority of possible effects on flood risk which may otherwise have arisen during the construction phase have been designed out through measures identified in the *CoCP* (Section 8) or within the design. Where the FRA indicates an increase in the level of flood risk having taken account of embedded measures, mitigation has been identified as appropriate.

15.8.3 The majority of possible effects on flood risk that may have arisen during the operational phase have been identified in the site specific FRAs and designed out with due regard for flood defences and surface water drainage systems. These are specifically outlined in each FRA.

15.8.4 The potential effects on flood risk in relation to the operational phase through scour and water level changes have been addressed in the project-wide assessment.

15.8.5 Monitoring is proposed in relation to scour implications on flood risk and more detail is contained within the project-wide assessment.

15.9 Residual risk

15.9.1 The residual risk is the flood risk that remains after any mitigation measures have been implemented and it is described within the FRAs as appropriate. If a substantive change in flood risk is identified, then for the purposes of EIA this is termed a ‘significant effect’.

15.9.2 The *Project wide* FRA includes details of the operational use of the sites and how this manages residual risk across the project.

References

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

[2] Environment Agency. *Thames Estuary 2100 Managing flood risk through London and the Thames estuary. TE2100 Plan* (November 2012). Available at: http://a0768b4a8a31e106d8b0-50dc802554eb38a24458b98ff72d550b.r19.cf3.rackcdn.com/LIT7540_43858f.pdf Accessed: 21 November 2012.

[3] Greater London Authority. *The London Plan: Spatial Development Strategy for Greater London* (July, 2011).

[4] Greater London Authority. *Securing London's water future: The Mayor's Water Strategy* (October, 2011).

[5] Department of Environment, Food and Rural Affairs (Defra). *National Planning Policy for Waste Water* (February 2012).

[6] Defra. *National Standards for sustainable drainage systems. Designing, constructing, operating and maintaining drainage for surface runoff. (Draft for consultation)* December 2011.

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

[8] Communities and Local Government. *Technical Guidance to the National Planning Policy* Fra*mework* (March 2012)

[9] Greater London Authority (July 2011). See citation above.

[10] Greater London Authority. *The London Plan Supplementary Planning Guidance: Sustainable Design and Construction* (May 2006).

[11] Greater London Authority, *The London Plan: Spatial Development Strategy for Greater London, Policy 5.13 – Sustainable Drainage* (July 2011).

[12] Greater London Authority. *London Regional Flood Risk Appraisal.* (October, 2009).

[13] Greater London Authority. *Drain London – Tier 2* (February 2011). Available at: http://www.london.gov.uk/drain-london.

[14] Greater London Authority (February, 2011). *See citation above.*

[15] *The Flood and Water Management Act (2010).*

[16] Environment Agency (November 2012). See citation above.

[17] HR Wallingford. *Combined Sewer Overflow Foreshore Works Tidal Flood Modelling – Overall impact upon the Tidal Thames (*November, 2011).

[18] Greater London Authority. *Surface Water Management Plan for City of London* (August, 2011).

[19] Greater London Authority. *Surface Water Management Plan for City of Westminster* (August, 2011).

[20] Greater London Authority. *Surface Water Management Plan for Royal Borough of Kensington & Chelsea* (August, 2011).

[21] Greater London Authority. *Surface Water Management Plan for the London Borough of Ealing* (October, 2011).

[22] Greater London Authority. *Surface Water Management Plan for the London Borough of Lambeth* (August, 2011).

[23] Greater London Authority. *Surface Water Management Plan for the London Borough of Lewisham* (August, 2011).

[24] Greater London Authority. *Surface Water Management Plan for the London Borough of Newham* (July, 2011).

[25] Greater London Authority. *Surface Water Management Plan for the London Borough of Richmond upon Thames* (October, 2011).

[26] Greater London Authority. *Surface Water Management Plan for the London Borough of Southwark* (August, 2011).

[27] Greater London Authority. *Surface Water Management Plan for the London Borough of Tower Hamlets* (August, 2011).

[28] Greater London Authority. *Surface Water Management Plan for the London Borough of Wandsworth* (September, 2011).

[29] Capita Symonds Ltd. *LB of Ealing Strategic Flood Risk Assessment Final Report* (March 2008).

[30] JBA Consulting. *London Borough of Hammersmith and Fulham and Royal Borough of Kensington and Chelsea Strategic Flood Risk Assessment* (June 2010)

[31] JBA Consulting. *LB of Greenwich Strategic Flood Risk Assessment Final Report* (October 2011).

[32] Jacobs Ltd. *LB of Richmond upon Thames Level 1 Strategic Flood Risk Assessment Final Report (Jun 2008).*

[33] Westminster City Council. *City of Westminster Strategic Flood Risk Assessment* (May 2010).

[34] Mouchel Parkman. *City of London Strategic Flood Risk Assessment* (August 2007).

[35] Jacobs. *London Borough of Lewisham Level 1 Strategic Flood Risk Assessment (*July 2008).

[36] Capita Symonds Ltd. *LB of Newham Strategic Flood Risk Assessment Final Report* (May 2010).

[37] Scott Wilson Ltd. *LB of Lambeth Level 1 Strategic Flood Risk Assessment Final Report* (June 2008).

[38] Scott Wilson Ltd. *LB of Lambeth Level 2 Strategic Flood Risk Assessment Final Report* (Aug 2008).

[39] London Borough of Southwark *Strategic Flood Risk Assessment (*SFRA*) Final Report.* (Feb 2008).

[40] Scott Wilson Ltd. *London Boroughs of Wandsworth, Merton, Sutton and Croydon Level 1 Final Report (Dec 2008).*

[41] Scott Wilson Ltd. *London Boroughs of Wandsworth, Merton, Sutton and Croydon Level 2 Final Report* (April 2009).

[42] Capita Symonds. *London Borough of Tower Hamlets Level 2 Strategic Flood Risk Assessment* (January 2012).

[43] Environment Agency. *Thames Tidal Defences Joint Probability Extreme Water Levels 2008 Final Modelling Report* (April 2008).

[44] Royal Haskoning. *Environment Agency Beverley Brook Flood Risk Mapping Study 2008* (March, 2009).

[45] Centre for Ecology and Hydrology. *Flood Estimation Handbook* (1999).

[46] Halcrow Group Limited. *Environment Agency River Wandle 2D Flood Modelling and Mapping Study* (March, 2010).

[47] Capita Symonds. *Lower Lee Valley Regeneration Strategy Strategic Flood Risk Assessment – Volume 1 Technical Report (*November, 2005).

[48] Capita Symonds *Environment Agency Lower Roding modelling study* (2009).

[49] Halcrow Group Limited. *Ravensbourne Flood Mapping Review TH660 – Volume 1 Final Modelling Report* (October 2009).

[50] Halcrow Group Limited. *The Ravensbourne Catchment Areas Benefiting From Defences Study – Modelling report* (November, 2010).

[51] Environment Agency. *National Flood and Coastal Defence Database* (October, 2011).

[52] Environment Agency. *Flood Maps* (May, 2012). Available at: http://maps.environment-agency.gov.uk

[53] Environment Agency (April 2008). See citation above.

[54] Defra. *National Standards for sustainable drainage systems. Designing, constructing, operating and maintaining drainage for surface runoff. (Draft for consultation)* December 2011.

[55] CIRIA. *C698 The SuDS Manual* (2007).

[56] National SuDS Working Group. *Interim Code of Practice for Sustainable Drainage Systems.* (July 2004)

[57] Environment Agency (April 2008). See citation above.

Thames Water Utilities Limited
Clearwater Court, Vastern Road, Reading RG1 8DB

DCO-DT-000-ZZZZZ-060202