16. WATER ENVIRONMENT

16.1 Introduction

16.1.1 This chapter presents information on the likely effects of the Scheme on hydrology, hydrological receptors, flood risk and surface water drainage. A full description of the Scheme is given in Chapter 4: Scheme Description and the Land to be Acquired or Used is provided in Volume 2 Preliminary Environmental Information Report: Drawings. Hydrogeology is covered in Chapter 12: Geology and Soils.

16.1.2 A full understanding of the existing water environment has been developed using a desk study approach, utilising baseline data collected from published and internet-based information sources and from key bodies, including the Environment Agency. This has been supplemented by results from a number of technical assessments.

16.1.3 As the Scheme is located within Flood Zone 3, in line with the National Planning Policy Framework (NPPF) (Ref 16-1) a stand-alone Flood Risk Assessment (FRA) has been prepared. The FRA is informed by the results of site specific hydraulic modelling and is provided in Appendix16.A of Volume 3 Preliminary Environmental Information Report: Appendices. Hydrodynamic Modelling has been completed for a proposed jetty, the results of which are reported in Appendix 16.B of Volume 3.

16.1.4 Design details regarding proposals to manage surface water drainage, have also been referenced to inform this chapter.

16.2 Regulatory and policy framework

16.2.1 This assessment has been undertaken in accordance with current international and national legislation, and national, regional and local plans and policies relating to the water environment in the context of the Scheme. A summary of the relevant legislation and policies, the requirements of these policies and Scheme response has been provided in Table 16-1 below.

Table 16-1 Water environment regulatory and policy framework

Policy/ Legislation	Summary of requirements	Scheme response
The EU Water Framework Directive 2000; Council Directive 2000/60/EC	The Water Framework Directive (WFD) provides a framework for the protection of surface (fresh) water, estuaries, coastal water and groundwater. The objectives of the WFD are to enhance the status, and prevent further deterioration, of aquatic ecosystems, promote the sustainable use of water, reduce pollution of water and ensure progressive reduction of groundwater pollution.	Pollution prevention and mitigation measures to be implemented are documented in a Preliminary Code of Construction Practice (CoCP). Access to pollution control facilities would be maintained and a spillage prevention plan would be implemented during construction and operation.
The Flood and Water Management Act 2010	The Flood and Water Management Act 2010 provides comprehensive flood risk management framework for people, homes and businesses. The Act encourages the use of sustainable drainage in new	A FRA has been prepared and can be found in Appendix 16.A of Volume 3. A strategy for dealing with surface water drainage has been developed in consultation with the EA and GLA. The strategy is based on the principles of providing treatment and attenuation of surface water runoff prior to discharge to watercourses and the existing sewer network. A Flood

Policy/ Legislation	Summary of requirements	Scheme response
	developments and re-developments. The non-statutory Technical Standards for Sustainable Drainage Systems (SuDS) has recently been published.	Evacuation Plan has been prepared that documents procedures to be followed in a flood emergency and can be found as part of the FRA in Appendix 16.A of Volume 3.
The Water Resources Act 1991	The Water Resources Act 1991 as amended sets out the regulatory regime under which water abstraction and impounding is licensed by the Environment Agency.	Surface water abstraction is discussed further in the PEIR in section 16.4.25. Consents requirements relating to the water environment are discussed in section 16.8.3. Pollution prevention and mitigation measures to be implemented are documented in a Preliminary Code of Construction Practice (CoCP).
National Policy Statement for National Networks (NN NPS) December 2014	NN NPS (Ref 16-2) sets out the need for, and Government's policies to deliver, development of nationally significant infrastructure projects (NSIPs) on the national road and rail networks in England. NN NPS	A drainage design has been drafted and is described within the Preliminary Engineering Report. A FRA has been prepared and can be found in Appendix 16.A of Volume 3.

Policy/ Legislation	Summary of requirements	Scheme response
	supports NPPF and explains that essential transport infrastructure is permissible in areas of high flood risk, subject to the requirements of the NPPF Exception Test.	
National Planning Policy Framework (NPPF) (March 2012)	The NPPF and online 'planning practice guidance' (http://planningguidance.planningportal.gov.uk/) set out the Government's planning policies for England and how these are expected to be applied. As the Scheme encroaches into Flood Zone 3, a standalone FRA is required to be prepared.	A FRA has been prepared and can be found in Appendix 16.A of Volume 3.
Construction Industry Research and Information Association (CIRIA) Development and Flood Risk:	CIRIA Development and Flood Risk guidance advises that all new developments should be designed so that surface water runoff is considered and, if appropriate, controlled for the lifetime of the	A strategy for dealing with surface water drainage has been developed to ensure surface water runoff is appropriately managed. The strategy considers the effects of climate change over the lifetime of the Scheme.

Policy/ Legislation	Summary of requirements	Scheme response
Guidance for the Construction Industry (C624)	development, including considerations for climate change. Safe access to and from the development should be available during a flood event.	A Flood Evacuation Plan has been prepared that documents procedures to be followed in a flood emergency and can be found as part of the FRA in Appendix 16.A of Volume 3.
Thames Estuary 2100 Plan (TE2100) (Ref 16-3)	The Plan divides the Thames Estuary into policy units and assigns a flood risk management approach to each unit. The policy applicable to the southern portal of the Scheme (Greenwich P5) encourages 'further action to reduce the risk of flooding (now and in the future).' The northern portal is within the Royal Docks policy unit (P4) where 'action to sustain the current scale of flood risk into the future is advocated.	The Scheme has been designed to ensure that existing river walls/defences are in no way undermined. Implementation of the TE2100 Plan would provide protection to the approaches over the lifetime of the Scheme, taking into account climate change.

Policy/ Legislation	Summary of requirements	Scheme response
The London Plan (2015) Greater London Authority	The London Plan (Ref 16-16) is the overall strategic plan for London, and it sets out a fully integrated economic, environmental, transport and social framework for the development of the capital to 2036. The key London Plan policy regarding flood risk management is Policy 5.12, which seeks 'to address current and future flood issues and minimise risks in a sustainable and cost effective way'. The policy requires planning decisions to comply with the flood risk assessment and management requirements set out in the NPPF and associated Technical Guidance.	A FRA has been prepared and can be found in Appendix 16.A of Volume 3.
Royal Greenwich Local Plan: Core Strategy	The Core Strategy forms the current development plan for the Borough	In line with Policies E17 and E18 a Surface Water Drainage Design has been developed to ensure surface water runoff is

Policy/ Legislation	Summary of requirements	Scheme response
(Ref. 16-4)	and contains a number of policies relevant to the Scheme. Policy E2 ensures that the sequential and exceptions tests are carried out and all forms of flood risk must be considered within flood risk assessments. Policy E3 ensures that developments in areas with a high residual risk classification should implement risk reduction measures with the primary aim of reducing risk to life. Applicants should also provide a flood plan detailing flood evacuation and flood response procedures. Surface water flooding can also be mitigated by the use of living roofs which are	appropriately managed and a FRA has been completed (See Appendix 16.A Volume 3). In line with Policy E19 where any works are to take place within 16m of a flood defence an application for consent would be made to the EA. The Scheme has been designed to ensure that existing river walls/defences are in no way undermined. In line with Policy E3 a Flood Evacuation Plan has been prepared.

Policy/ Legislation	Summary of requirements	Scheme response
	encouraged by Policy E(f) Living Roofs and Walls. Superseded Saved UDP Policies; Policy E17 concerns drainage and flood protection, requiring that all development is controlled so as not to give rise to flooding, surface, and groundwater or aquifer pollution. Surface water should be disposed of as close to source as possible, or attenuated before discharge to a watercourse or surface water sewer. Surface water should not be allowed to enter the foul system. Policy E18 states that planning applications for development on sites of more than 1 hectare must be accompanied by a FRA appropriate to	

Policy/ Legislation	Summary of requirements	Scheme response
	the scale of and nature of the development, the level of flood risk, and the protection afforded by the existing defences. Policy E19 All new developments will be protected from flooding by existing tidal and fluvial flood defences. Where works are being carried out in proximity to a tidal or fluvial flood defence the Council will seek to safeguard, and where possible extend, public access to the waterfront and protect and enhance existing ecological features.	
Local Plan: Core Strategy – London Borough of Newham (Ref. 16-5)	The Newham Core Strategy forms the current development plan for the Borough. Policies relevant to the Scheme are:	In line with Policy 3.123 a FRA has been prepared and can be found in Appendix 16.A of Volume 3. A strategy for dealing with surface water drainage has been developed to ensure surface water runoff is appropriately managed.

Policy/ Legislation	Summary of requirements	Scheme response
	Policy SC3 Objective 6.168 *Development must be shown to be flood resistant and regeneration should improve the resilience of those parts of the borough at risk from flooding*. Saved Policy 3.123 The council will not permit development which is likely to adversely affect the water environment or which would prove unacceptable to the EA and other bodies.	Pollution prevention and mitigation measures are documented in a Preliminary CoCP.
London Borough of Newham Level 2 SFRA and London Borough of Greenwich SFRA (Ref. 16-6, Ref. 16-7)	SFRAs are intended to guide development decisions and allow Local Planning Authorities to apply the NPPF Sequential Test. Both the SFRAs recognise that development on land that is outside	A FRA has been prepared and can be found in Appendix 16.A of Volume 3. The FRA concludes that the Scheme passes both the NPPF sequential and exception tests.

Policy/ Legislation	Summary of requirements	Scheme response
	Flood Zones 2 and 3 should be pursued first. Newham SFRA and the Greenwich SFRA predict floodwater depths of 3.1m and 2.6m at the proposed northern and southern tunnel approaches, respectively, during a 1 in 200 year plus climate change breach event.	

16.3 Methodology

General approach

16.3.1 The approach outlined below has been followed in preparing the Water Environment chapter of the PIER.

16.3.2 The assessment has consisted of a desk based study to establish baseline conditions informed by published and internet-based information sources, supplemented with responses to direct consultation requests.

16.3.3 The impact assessment has been carried out in accordance with the guidance set out in the Design Manual for Roads and Bridges (DMRB), Volume 11, Section 3, Part 10 (Ref 16-8) and also includes an assessment of the potential for cumulative effects. As the Scheme is located within Flood Zone 3, in line with NN NPS and the NPPF, a stand-alone FRA has also been prepared.

16.3.4 Potential impacts of the construction and operational phases of the Scheme have been identified and assessed considering mitigation measures embedded into the Scheme design.

Consultation

16.3.5 Further consultation has been undertaken since the receipt of the responses to the EIA Scoping Report (16-9) and Introductory Environmental Report (Ref 16-10) to agree a range of issues particular to the Water Environment assessment. Table 16-2 summarises this consultation.

Table 16-2 Water environment consultation

Consultee	Date of consultation	Summary of consultation
Environment Agency	16 December 2014	Meeting with EA, TfL and the design team regarding flood risk issues. The main outcome of this meeting was that bespoke site specific flood defence breach modelling was requested by the EA and the scope of this modelling assessment was agreed.

Consultee	Date of consultation	Summary of consultation
Environment Agency	11 February 2015	Request for EA Flood product 4 and 8 data.
Environment Agency	1 April 2015	Request for EA Flood product 7 data, the existing EA breach model of the River Thames in the study area.
Environment Agency	17 April 2015	Consultation has been undertaken to request details of any licensed abstractions or consented discharges to surface waterbodies within the study area. It was shown that there are no surface water abstraction points within the limit of land to be acquired or used land to be acquired or used or within a 1km radius of the its boundary. However, there are 8 surface water abstractions within a 5km radius of the site.
Environment Agency	12 June 2015	Meeting with EA and TfL regarding flood risk issues. The EA noted that the flood defences should be raised to heights proposed in TE2100 plan, not just above the predicted TE2100 in-channel water levels. The EA visually inspect the flood defences every six months. This is discussed further in sections 16.3.16 and 16.4.15. The EA stated that in addition to ensuring the defence lasts the lifetime of the Scheme, the design should allow for defences to be raised in the future. The design should make it possible to maintain the defence from the landward side. This would involve ensuring there is enough space for plant to access the defence for maintenance purposes. This is discussed further in section 16.5.6.
Greenwich and Newham Borough Councils	17 April 2015	Consultation has been undertaken to request details of any private water supplies in the study area. Confirmation has been received

Consultee	Date of consultation	Summary of consultation
		that the Borough Councils have no records of private water supplies within the study area.

The study area

16.3.6 The study area has been defined to reflect the surrounding water environment and following consideration of the distance over which significant effects can reasonably have the potential to occur. This approach is in line with the DMRB guidelines.

16.3.7 The study area (Drawing 16.1 Volume 2) includes the area within the land to be acquired or used, in addition to downstream reaches of the Rivers Thames, River Lea and the Royal Victoria Dock, and any other surface water receptors identified within 500m of the land to be acquired or used.

Methodology for establishing baseline conditions

16.3.8 Baseline information has been gathered by:

- identifying appropriate study area in consideration of the Scheme details;
- taking into consideration issues raised through consultation with interested parties (including during and post-scoping);
- undertaking a desk study (including requesting information from third parties) within agreed study area(s); and
- undertaking a site walkover on 29 May 2014. The walkover comprised a visual assessment of the study area to develop an understanding of the hydraulics and hydrology of identified water features. It should be noted that, due to access restrictions, not all of the study area could be accessed during the walkover.

16.3.9 Guidance outlined in the following documents was also used to inform the baseline information gathering and has been referenced, where applicable, as part of the impact assessment process:

- British Standards Institute (BSI) (2009). Code of Practice for Earthworks (BS6031) (Ref 16-11);
- CIRIA (2001). C532 Control of Water Pollution from Construction Sites (Ref 16-12);
- CIRIA (2005). C650 Environmental Good Practice On-Site (Construction Industry Research and Information Association (Ref 16-13);
- Planning Practice Guidance (Ref 16-14) which sets out the Government's planning policies for England and how these are expected to be applied. (http://planningguidance.planningportal.gov.uk/blog/guidance/flood-risk-and-coastal-change/planning-and-flood-risk/)
- Department for Communities and Local Government (2012). NPPF (Ref 16-1);
- EA (2014). Pollution Prevention Guidance. Various publication dates (accessed via https://www.gov.uk/government/collections/pollution-prevention-guidance-ppg) (Ref 16-15); and
- Highways Agency (2009). Design Manual for Roads and Bridges (DMRB) Volume 11, Section 3, Part 10 (HD 45/09) (16-8).

Desk study

16.3.10 A desk study was undertaken to obtain information relating to the water environment baseline, from the following sources:

- Ordnance Survey (OS) Mapping;
- Topographic Survey;
- Preliminary Engineering Report Drawing;
- Environment Agency online data sets for water quality and pollution incidents;
- Environment Agency Product 4, 7 and 8 flood data;

- MAGIC Interactive Mapping;
- British Geological Survey (BGS) Geology of Britain Viewer; and
- 1:250000 Soil Map of England and Wales, Soil Survey of England and Wales 1983.

Modelling studies and surveys

16.3.11 In addition to the collection of baseline data from published sources, a number of bespoke modelling studies and surveys have been carried out. These have been undertaken to both supplement the understanding of baseline conditions and to quantify the impacts of the Scheme on different aspects of the water environment.

16.3.12 To quantify flood conditions, associated with potential breaches of the River Thames defences at locations local to the Scheme, a breach modelling study is currently underway. The breach modelling methodology involves assessing where a breach is most like to happen and then representing this in a 2D model that routes water over the floodplain and allows flood extents, water levels (depths) and flow velocities to be calculated. Two separate breach models are currently being developed, one for the Silvertown site and one for the Greenwich site. Both breach models are based on the most current Environment Agency ISIS-TUFLOW model (received in August 2015) and will simulate a 1 in 200 year tidal flood event. The results of the modelling will then be used to quantify breach flood conditions local to the Scheme, for example, floodwater depths, flow velocities and speed of inundation. This information will be used to inform the Silvertown Tunnel Flood Warning and Evacuation Plan that sets out flood emergency response actions and are the key means of mitigating flood risk during both construction and operational phases of the Scheme. Key model parameters, for example breach locations, have been agreed with the Environment Agency. The results of the breach modelling will be incorporated into the final ES and whilst the results are unlikely to change the assessment presented in this PEIR, the data generated will be used to update and inform the Scheme Flood Evacuation Plan.

16.3.13 TfL has also completed an assessment of the impact of construction of a new jetty in the River Thames at the Silvertown site on water levels, flow velocities, sediment transport and scour. This assessment has involved modelling the change in local currents due to the movement of water around the jetty piles using MIKE21FM hydrodynamic modelling software. The model was constructed using bathymetry data supplied by the Port of London Authority (PLA) at 10m resolution and referenced to Chart Datum and hydrodynamic boundary conditions were extracted from the HR Wallingford River Thames model.

16.3.14 A range of tidal and river flow conditions were simulated with and without the jetty structure so that the differences in hydrodynamic conditions due to the jetty could be examined.

16.3.15 In addition to the modelling studies outlined above, TfL has completed a River Wall Structural Condition Survey (Appendix 16.D) of key sections of the defences within the land to be acquired or used. The survey has characterised the existing condition grade of the defences, recorded any observations of settlement, identified sections of defence where raising will be needed to meet current and future flood defence levels (of +5.18m AOD and +6.20m AOD respectively) and identified the potential feasibility of raising existing defences, i.e. increasing their crest heights, to meet future defence standards after the Scheme has been constructed.

Forecasting the future baseline ('without scheme' scenario)

16.3.16 Future baseline conditions with regard to water quality, in the absence of the Scheme, relevant to the Scheme opening year (2023), have been forecast by taking into consideration legislative drivers, environmental trends, including the potential effects of climate change, and other currently consented developments.

16.3.17 With regard to flood risk the impacts of climate change have been forecast and modelled to the year 2065. This has been agreed with the Environment Agency and is in line with the climate change scenarios assessed in the TE2100 Plan (Ref 16-3).

Defining the importance/sensitivity of resources

16.3.18 The following section outlines the criteria that have been used to determine the assessment of effects.

16.3.19 The approach to the assessment of potential effects on the water environment follows the assessment criteria drawn from Part 10 of Volume 11 of the DMRB (Ref 16-8), with reference to the paper Practical Methodology for Determining the Significance of Impacts on the Water Environment (Ref 16-17).

16.3.20 The assessment methodology comprises a number of stages. The first stage involves making a judgement as to the importance (sensitivity) of the affected attributes of the surface water and flood risk receptors identified, which is assigned to one of the categories defined in Table 16-3.

Table 16-3 Determining the importance / sensitivity of resource

Importance/ sensitivity of resource or receptor	**Criteria**	**Typical examples**	
Very High	Attribute has a high quality and rarity on a regional or national scale	Surface water:	European Union (EU) designated Salmonid/Cyprinid fishery Watercourse achieving WFD Class 'High' Site protected under EU or United Kingdom (UK) wildlife legislation (Special Area of Conservation, Special Protection Area, Site of Special Scientific Interest, Ramsar site) Supports a public potable water supply to a large community
		Flood risk:	Designated washland or a large and active floodplain where there is high potential for flooding of a large number (> 100) of residential properties and infrastructure

Importance/ sensitivity of resource or receptor	Criteria	Typical examples	
High	Attribute has a high quality and rarity on a local scale	Surface water:	Watercourse achieving WFD Class 'Good'
		Flood risk:	Floodplain or defence protecting between 1 and 100 residential properties or industrial premises/key infrastructure from flooding
Medium	Attribute has a medium quality and rarity on a local scale	Surface water:	Watercourse achieving WFD Class 'Moderate' Water feature that supports an abstraction for agricultural or industrial use of between 50 and 499m^3/day, or supports a private water supply of potable water to an individual property
		Flood risk:	Floodplain or defence protecting ten or fewer industrial properties from flooding
Low	Attribute has a low quality and rarity on a local scale	Surface water:	Watercourse that is not a fishery, achieving WFD Class 'Poor' Supports an abstraction for agricultural or industrial use of < 50m^3/day. Does not support a public or private potable water supply
		Flood risk:	Floodplain within limited constraints and a low probability of flooding of residential and industrial properties

Source: Part 10 of Volume 11 of the DMRB, with reference to the paper Practical Methodology for Determining the Significance of Impacts on the Water Environment (Ref 16-9).

Methodology for assessing impact magnitude and effect significance

16.3.21 The magnitude of impact is then assessed considering the scale, extent of change, nature and duration of impact. Definitions of the magnitude of

impact are given within Table 16-4 which provides examples of each scale of impact.

Table 16-4 Assessing magnitude of impact

Magnitude of impact	**Criteria**	**Typical example**	
Major adverse	Results in loss of attribute and/or quality and integrity of the attribute	Surface water: Flood risk:	Loss or extensive change to a fishery Loss or extensive change to a designated Nature Conservation Site Change in the WFD class of a river reach or pollution of a potable source of abstraction Increase in peak flood level (1% Annual Exceedance probability (AEP)) >100 mm, or increasing the risk of flooding to >100 residential properties
Moderate adverse	Results in effect on integrity of attribute, or loss of part of attribute	Surface water: Flood risk:	Partial loss in productivity of a fishery Pollution of a non-potable source of abstraction Increase in peak flood level (1% AEP) >50 mm, or increased flood risk to <100 residential properties
Minor adverse	Results in some measurable change in attribute quality or vulnerability	Surface water: Flood risk:	Discharges to a watercourse that result in no significant loss of quality, fishery or biodiversity value Increase in peak flood level (1% AEP) <50 mm or increasing the risk of flooding to <10 industrial properties
Negligible	Results in effect on attribute, but of insufficient magnitude to	The proposed Scheme is unlikely to affect the integrity of the water environment. Negligible change in peak flood level.	

Magnitude of impact	Criteria	Typical example	
	affect the use or integrity		
Minor beneficial	Results in some beneficial effect on attribute or a reduced risk of negative effect occurring	Surface water: Flood risk:	Reduction in discharges of either soluble or sediment bound pollutants Reduction in peak flood level (1% AEP) >10 mm
Moderate Beneficial	Results in moderate improvement of attribute quality	Surface water: Flood risk:	Reduction on discharges of both soluble and sediment bound pollutants Reduction in peak flood level (1% AEP) >50 mm
Major Beneficial	Results in major improvement of attribute quality	Surface water: Flood risk:	Total removal of existing polluting discharge, or removing the likelihood of polluting discharges occurring to a watercourse. Reduction in peak flood level (1% AEP) >100 mm

Source: Part 10 of Volume 11 of the DMRB, with reference to the paper Practical Methodology for Determining the Significance of Impacts on the Water Environment (Ref 16-17).

16.3.22 A combined assessment of receptor importance/sensitivity and impact magnitude is then undertaken to determine the significance of effect, as demonstrated in Table 16-5. Effects can be either beneficial or adverse. Where an impact magnitude is considered to be negligible, its overall significance of effect is classified as neutral no matter the sensitivity of the receptor. Please note that in Table 16-5 the shaded elements of the table mean significant in EIA terms.

Table 16-5 Assessing significance of effect

		Magnitude of impact			
		Negligible	**Minor**	**Moderate**	**Major**
Sensitivity of attribute	**Very High**	Neutral	Moderate	Large	Very Large
	High	Neutral	Slight/ Moderate	Moderate/ Large	Large/ Very Large
	Medium	Neutral	Slight	Moderate	Large
	Low	Neutral	Neutral	Slight	Moderate

Source: Part 10 of Volume 11 of the DMRB, with reference to the paper Practical Methodology for Determining the Significance of Impacts on the Water Environment (Ref 16-17).

16.3.23 Professional judgement has been used when assigning overall significance where there is a choice, with adherence to the precautionary principle.

Limitations and assumptions

16.3.24 Flood risk to the Scheme has been defined and assessed using currently available data from the Environment Agency, supplemented by data generated by bespoke, site specific flood defence breach modelling. The breach modelling is currently being undertaken and the results will be included in the final ES.

16.3.25 The water quality of water environment receptors has been defined using published data sources, with no sampling surveys undertaken. Given the availability of contemporary data with which to define the sensitivity (value) of these attributes it is considered that this approach is acceptable.

16.4 Description of the baseline conditions

Existing baseline

16.4.1 The following section outlines the baseline information obtained through desk based studies, a site walkover and consultation. The value of identified receptors is summarised in Table 16-6 and these receptors are illustrated in Drawing 16-1 Waterbodies and Watercourses in Volume 2.

16.4.2 The study area is characterised by highly urbanised land use and a gently undulating topography, with ground levels varying between approximately 3m and 7m Above Ordnance Datum (AOD). The study area receives an average annual rainfall of approximately 570mm and its hydrology is dominated by the tidal River Thames, which supports numerous functions, for example, the transport of dilution of waste water discharges, commercial and recreational navigation and diverse fisheries. Other surface water features in the study area are:

- The River Lea (river reach within the study area known as the Bow Creek). This river has its confluence with the River Thames adjacent to the western boundary of the northern worksite.
- The Royal Victoria Dock, a tidal basin located approximately 100m to the east of the Silvertown site.
- Minor watercourse, known as '*The Cut'*, that has an open channel section located approximately 120m south-west of Dock Road within the Silvertown site and an associated balancing pond.
- Unnamed minor watercourse that has an open channel section located approximately 180m north-west of the southern portal of the Scheme.

Water quality

16.4.3 The monitoring and assessment of the chemical and ecological quality of surface waters is currently driven by the Water Framework Directive (WFD), which requires the physical, ecological and chemical condition of waters to be assessed, with plans and actions put in place to improve the condition towards '*Good*' status. A WFD screening exercise has been undertaken and can be found in Appendix 10.A. A full WFD assessment will be undertaken, the results of which will be included in the final ES.

16.4.4 The chemical and biological water quality of the Thames Estuary is monitored under the requirements of the WFD.

16.4.5 Data presented in the Thames River Basin Management Plan (Ref 16-18) indicate that the current ecological status of the River Thames is Moderate and that that the chemical status of this waterbody fails to achieve WFD targets.

16.4.6 The River Thames and reach of the River Lea located in the study area are classified as a heavily modified waterbodies (HMW), serving flood protection and navigation functions. Their current ecological potential is defined as Moderate, limited by the status of the benthic invertebrate community and hydro-morphological quality, and their current chemical quality fails WFD objectives. Environmental Quality Standards (EQS) for a number of priority hazardous substances are exceeded, namely Tributyltin Compounds, Diuron and Benzo perelyene & indeno pyrene.

16.4.7 These waterbodies have a target of achieving Good Ecological Potential and Chemical Status by 2027 and a number of mitigation measures have been set out to achieve this goal. Further information on the aquatic ecology of the River Thames is provided in Chapter 10: Marine Ecology.

16.4.8 As the rivers are tidal at the location of the Scheme, there is a high degree of water mixing and high suspended solids. The highest suspended solids value recorded on the River Thames between 2000 and June 2010 is 551 milligrams per litre (Solid/sus@105) in October 2004 with an average value of 74.5 milligrams per litre (Ref 16-19).

16.4.9 The water quality of Royal Victoria Dock is not assessed by the Environment Agency under the WFD. However, water in the dock is tested regularly against rigorous standards applicable to recreational waters, which include compliance with physical and bacteriological limits. Although failures periodically occur, usually because of algae growths in the summer months, generally, the water quality is good and meets Bathing Water Directive standards (Ref 16-20).

16.4.10 The water quality of two minor watercourses located in the study area is not assessed by the Environment Agency under the WFD and no dataset is available to define their baseline quality. The value of their water quality attributes has therefore been inferred based on their physical characteristics and surrounding land use.

16.4.11 Pollution incidents having a major or significant effect on the water environment are recorded by the Environment Agency and data can be accessed via the Environment Agency website (Ref 16-19). A search of this information has illustrated that the River Thames has been subject to periodic incidents that have resulted in pollution with sewage materials.

16.4.12 Within the study area there are a number of historical landfill sites and the area also has a history of heavy industrial land use. This leads to the potential for a legacy of soil contamination and should construction activities disturb/mobilise contaminates in the soil, this could result in adverse effects on the water quality of local surface and groundwater bodies. The results of a ground investigation and further details regarding land contamination and implications for the quality of water environment receptors are provided in Chapter 12: Geology and Soils.

16.4.13 Based on the baseline information available to date, and in accordance with the definitions of receptor importance in Table 16-3 the water quality attributes of the River Thames are assigned medium sensitivity, the River Lea (Bow Creek) is assigned medium sensitivity, the Victoria Dock is assigned high sensitivity and the unnamed watercourses are assigned a low sensitivity.

Flood risk and drainage

16.4.14 A FRA has been undertaken and is provided in Appendix 16A of Volume 3. The FRA describes baseline flood risk to the Scheme from all sources (fluvial, tidal, surface waters, sewers, groundwater and artificial waterbodies) and key findings are summarised below.

16.4.15 To the south of the River Thames the Scheme is located wholly within Flood Zone 3, in the 1 in 200 year floodplain of the River Thames. The majority of the Silvertown site and tunnel portal is also located in Flood Zone 3, but a small area is located in Flood Zone 2 in the 1 in 1000 year floodplain. All areas within the land to be acquired or used benefit from defences and actual flood risk is reduced by the presence of flood defence infrastructure.

16.4.16 The flood defences along the River Thames in the study area comprise of raised, man-made river walls that are privately owned. The defences are inspected twice a year by the Environment Agency and must be maintained by their owners to a statutory crest level of 5.18 m AOD. The main source of flood risk to the Scheme is from a breach of existing defences in combination with extreme tide levels in the Thames Estuary.

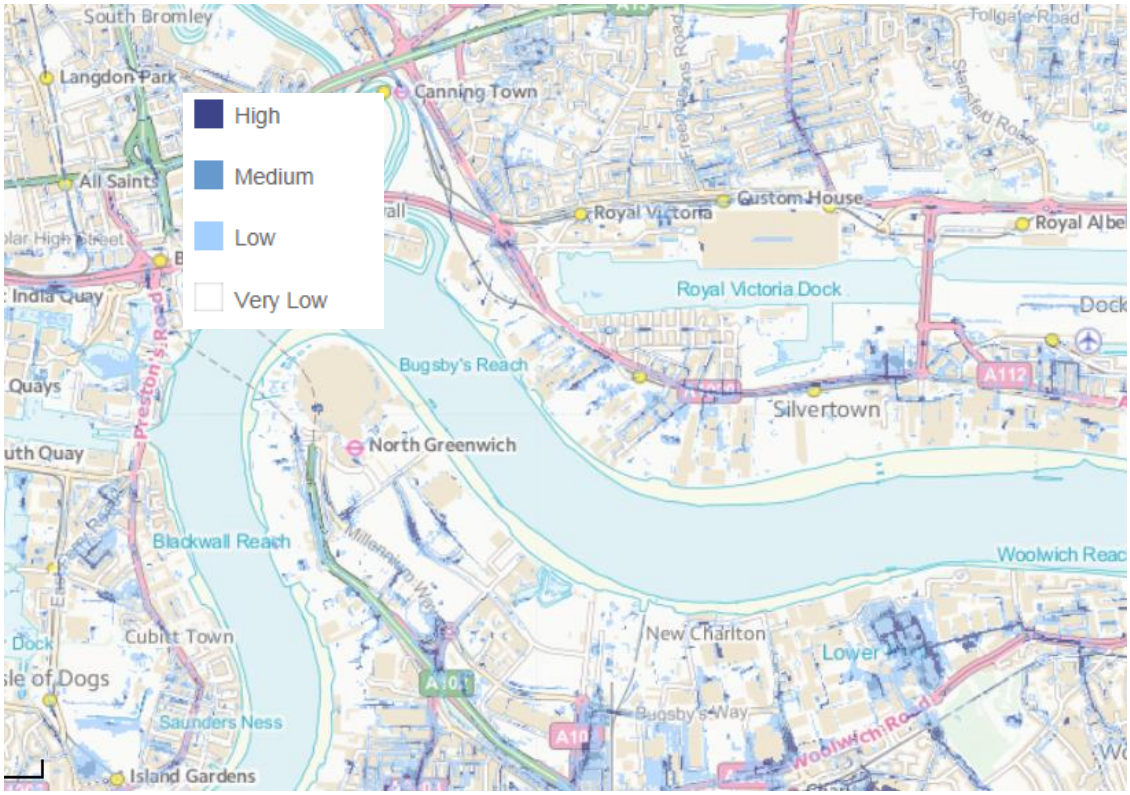
16.4.17 The Environment Agency has highlighted the poor condition of a section of the existing river wall around the Bow Creek, which is located relatively

close to the Silvertown site. A River Wall Structural Condition Survey has been undertaken (Appendix 16.D), to assess the condition and standard of protection offered by the river walls along the north and south banks of Thames adjacent to the Scheme. The survey results reveal variable condition ratings along different sections of the defences, ranging from Grade 2 (Good) to 4 (Poor). No evidence of settlement was observed and the surveyed defences were generally within 0.1m of the Environment Agency statutory defence level of 5.18m AOD.

16.4.18 Records of several historical flood events have been collected. Land within the study area, including the Silvertown and Greenwich sites, were subject to tidal flooding, due to a storm surge in the North Sea, on the night of the 31 January and into the morning of 1 February 1953, when the River Thames reached an approximate level of 5.26 m AOD. Parts of the Silvertown site were also affected by flooding from the River Thames in 1947. It should however be noted that since these historic flood events the standard of flood protection within the study area has significantly improved, with the addition of the Thames barrier.

16.4.19 According to the Environment Agency surface water flood maps (Figure 16-2) the majority of the Scheme is located in an area of '*very low'* surface water flood risk (less than 1 in 1000 chance). There are some small isolated areas where the Scheme is at low (between 1 in 1000 and 1 in 100 chance), medium (between 1 in 100 and 1 in 30 chance) and high (greater than 1 in 30 chance) risk of surface water flooding, for example, the road which forms the approach to the southern portal of the tunnel is classed as at low risk of surface water flooding.

Figure 16-2 Surface water flood map



Source: http://apps.environment-agency.gov.uk/wiyby/37837.aspx

16.4.20 Surface water runoff from the study area is drained by a sewer system comprising an integrated network of combined sewers that ultimately discharge into the River Thames. The existing drainage catchment of the Silvertown site comprises North Woolwich Road, Dock Road, the A1020 Lower Lea Crossing and the A1011 Silvertown Way. The drainage system on these roads is mainly kerb and gully discharging into carrier drains. In the northern portal area four existing waste handling and recycling sites drain, via a balancing pond, to '*The Cut'*, which in turn discharges to the River Thames. Issues relating to the condition and suitability of the drainage system serving these sites have been highlighted by the Environment Agency. It is understood that at the Silvertown site the existing drainage systems are failing, resulting in pollution of the local water environment.

16.4.21 At the Greenwich site, the existing drainage catchment includes areas of the A102 Blackwall Tunnel Approach and Tunnel Avenue. The drainage

services on both the A102 Blackwall Tunnel Approach and Tunnel Avenue are maintained by Thames Water. The drainage system on these roads comprises a kerb and gully system discharging directly into carrier drains.

16.4.22 Based on information available to date, and in accordance with the definitions of receptor sensitivity in Table 16-3, the existing flood risk and drainage attributes of the study area are assigned High sensitivity, as the defended floodplain of the River Thames accommodates dense urban development and existing drainage infrastructure serves a large population.

16.4.23 With regard to flood risk from other sources, the FRA has concluded that the Silvertown and Greenwich sites are not at significant risk of groundwater flooding, or flooding from sewers and artificial sources.

Existing abstractions and discharges

16.4.24 Consultation has been undertaken with the Environment Agency and relevant local authorities to identify any licensed abstractions or private water supplies supported by surface water resources within the study area.

16.4.25 Environment Agency records include no surface water abstraction points within a 1km radius of the land to be acquired or used. However, there are 8 surface water abstractions within a 5km radius. These are listed in Table 16-6 and illustrated in Drawing 16-1 Waterbodies and Watercourses. Consultation responses from relevant local authorities have not identified any further licensed abstractions or private water supplies supported by surface water resources within the study area.

Table 16-6 Surface water abstraction points within 5km of the land to be acquired or used

Permit	Permit holder	Grid Reference
28/39/39/0204	Canal and River Trust	TQ37287997
28/39/44/0016	London Underground Limited	TQ388782

Permit	Permit holder	Grid Reference
28/39/44/0022	United Marine Aggregate LTD	TQ40317918
28/39/44/0033	Cemex UK Materials Limited	TQ40397928
28/39/44/0045	Day Group LTD	TQ40607910
TH/039/0039/048	Canal and River Trust	TQ3760279104

16.4.26 In response to an information request, the Environment Agency confirmed that they hold no records of consented discharges to surface waterbodies within the study area. However, in the wider area, the Thames Estuary and River Lea receive consented discharges from the public sewer network and are considered to serve an important role in the transport/dilution of wastes.

16.4.27 In accordance with the definitions of receptor importance presented in Table 16-3, surface waters within the study area are assigned low sensitivity with regard to their function of supporting water supply abstractions and sensitivity ranging from high to low with regard to the transport and dilution of waste water discharges.

Recreation

16.4.28 There are a number of water-based recreational activities in the area surrounding the Scheme such as the Greenwich Yacht Club, kayaking and the Thames Rib experience. The Victoria Dock itself is accessible to ships, although its western entrance has been filled in and it is now used chiefly for water sports. In accordance with the definitions of receptor importance presented in Table 16-3, the recreational attributes of water features within the study area are assigned a medium sensitivity.

16.4.29 A summary of surface water receptors, their attributes and assigned sensitivity is presented in Table 16-6.

Table 16-6 Sensitivity of receptors summary

Receptor		Sensitivity	Reasoning
River Thames Estuary	Water Quality	**Medium**	Watercourse achieving WFD Class 'Moderate'.
	Flood Risk	**High**	Floodplain or defence protecting between >100 residential properties or industrial premises/key infrastructure from flooding.
	Water resources – water supply	**Low**	No surface water abstraction points that development could impact on.
	Water resources – transport/ dilution of wastes	**High**	Receives consented discharges of waste water in the wider study area.
	Recreation	**Medium**	Supports a number of water sport activities
River Lea (Bow Creek)	Water Quality	**Medium**	Watercourse achieving WFD Class 'Moderate'.
	Flood Risk	**High**	Floodplain or defence protecting between >100 residential properties or industrial premises/key infrastructure from flooding.
	Water resources – water supply	**Low**	No Surface water abstraction points that development could impact on
	Water resources – transport/dilution of wastes	**High**	Receives consented discharges of waste water in the wider study area

Receptor		Sensitivity	Reasoning
Royal Victoria Dock	Water Quality	**High**	Achieves compliance with Bathing Waters Directive standards
	Flood Risk	**Low**	Water levels are managed and controlled to avoid flood risk to the surrounding land
	Water resources – water supply	**Low**	No surface water abstraction points that development could impact on
	Water resources – transport/dilution of wastes	**Low**	Environment Agency have no records of consented discharges to this waterbody.
	Recreation	**Medium**	Supports a number of water sport activities
The Cut	Water Quality	**Low**	Watercourse known to suffer from heavy siltation and to receive poor quality drainage discharges.
	Flood Risk	**Low**	Minor watercourse with small catchment area, receiving land drainage from an industrial site.
	Water resources – water supply	**Medium /**	Receives surface water drainage discharges from four waste handling/recycling sites at Thames Wharf.
	Water resources – transport/dilution of wastes	**Low**	No surface water abstraction points.
Unnamed watercourse in Southern portal study area	Water Quality	**Low**	Watercourse that does not support a fishery and is of low rarity at the local scale
	Flood Risk	**Low**	Minor watercourse with small catchment area, receiving land drainage from an industrial area.

Receptor		Sensitivity	Reasoning
	Water resources – water supply	**Low**	No Surface water abstraction points that development could impact on
	Water resources – transport/dilution of wastes	**Low**	Environment Agency have no records of consented discharges to this waterbody.

Future baseline

16.4.30 Regardless of the Scheme, the current water environment would be subject to future temporal variations. For example, it is anticipated that baseline water quality throughout the study area would be subject to variation. Whilst it is unknown whether the overall future trend will be for water quality improvements or degradation, legislative drivers, for example, the WFD (Ref 16-16) will encourage future water quality improvements.

16.4.31 The Thames Tideway Tunnel Scheme would also have a bearing on future water quality, by controlling 34 of the most polluting combined sewer overflows (CSOs) to the River Thames, resulting in benefit to the reach of the river upstream of the study area, with a knock on benefit for all reaches of the river downstream also.

16.4.32 Climate change is anticipated to increase peak rainstorm intensities, resulting in increases in fluvial flow peaks and surface water runoff, and result in sea level rise, which has the potential to increase future baseline flood risk within the study area. Climate change is a key driver toward setting future flood risk management policy in the River Thames. The future direction for flood risk management in the study area is set out in the TE2100 Plan (Ref 16-3) which states that existing flood defences will be maintained and improved to ensure a 1 in 1000 standard of protection to the year 2100.

16.4.33 The construction and operation of currently consented developments, which include major mixed use redevelopment of the Leamouth

Peninsular adjacent to the Bow Creek (River Lea) and development of several parcels of land with a River Thames frontage on the Greenwich Peninsula, has the potential to influence the future water environment baseline. Examples include an increased demand on water resources associated with water use and generation of additional waste water discharges. However, each consented development would be subject to planning conditions that would safeguard the local water environment. In addition, each consented development would be designed to include measures that would facilitate appropriate levels of flood protection over their development lifetimes, to counteract the predicted increase in baseline flood risk due to the effects of climate change. The construction and operation of Thames Tideway Tunnel also has the potential to influence the future water environment baseline by reducing surface water runoff. The main aim of Thames Tideway Tunnel is to provide storage for combined raw sewage and rainwater discharges that currently overflow into the river.

16.4.34 In summary, it is considered that there will be improvements in the future baseline water quality and improvements in flood protection standards that would keep pace with climate change.

16.5 Scheme design and mitigation

16.5.1 The following section outlines relevant aspects of the Scheme design and construction approach, including proposed future monitoring and management plans that have been considered in this assessment.

Construction

Measures to prevent or reduce water quality impacts

16.5.2 During the construction phase a drainage system would be operational which would help control the potential for pollution of surface waters associated with construction site runoff having elevated concentrations of silt or contamination from fuels, oils, cement etc. The drainage system would incorporate pollution control systems built as early in the construction sequence as is practicable, for example oil interceptors and facilities to control runoff from earthworks and allow silt to settle before discharge within consented parameters.

16.5.3 The drainage system would be based on the principles of attenuated and treated discharge. Provision would be made to provide a storage facility at the limiting discharge rate for a 1 in 100 year critical duration storm including an appropriate allowance for climate change. The storage could be provided in the form of oversized pipes of suitable diameter, storage tanks or large size chambers or a combination of these at suitable locations within the network. During the construction phase temporary pumping stations would be installed at the entrance of the tunnel portals to ensure surface water runoff does not enter the tunnel excavation sites.

16.5.4 At the Silvertown site existing drainage systems are failing, resulting in pollution of the water environment. Construction of Silvertown tunnel will involve removing all of these polluting land uses and introduce new drainage across the site. During the construction phase of the Scheme, works would be undertaken to provide a drainage system that is fit for purpose for the Scheme, improving the quality of drainage discharges to receiving waters, namely the Cut and the River Thames.

16.5.5 Other pollution prevention and control measures are documented in the Preliminary CoCP (Appendix 4.B), which will set out the framework for a Construction Environmental Management Plan (CEMP) to be prepared by the Design Build Finance Maintain (DBFM) contractor of the Scheme.

16.5.6 The CEMP will document good practice pollution prevention methods for activities such as excavation and dewatering, storage of fuels, chemicals and oils, vehicle washing, pollution control, and emergency contingency. Access to pollution control equipment and spillage clean up facilities would be provided and a Spillage Prevention Plan would be in place and would include measures to be taken to prevent pollution caused by severe weather.

16.5.7 Foul drainage, for example, from construction compound welfare facilities, would be piped to a local wastewater treatment plant or at smaller compounds, treated on site and regularly collected. The local wastewater treatment plant has capacity for this.

16.5.8 There is potential to encounter contaminated soils during construction activities such as boring and other earthworks. This has an associated risk of mobilising pollutants that could enter surface waterbodies to the

detriment of their water quality. The working practices that would be put in place to prevent and manage this issue are described in Chapter 12: Geology and Soils.

16.5.9 Any ingress of water into excavations would be pumped to a suitable settlement lagoon or tank and the clear water discharged into the drainage system in a condition suitable to meet the requirements of the Environment Agency / Thames Water as applicable.

16.5.10 Construction of the Scheme would be estimated to generate approximately 120,000tonnes of excavated materiall. Arisings from the Silvertown site would be screened at a spoil storage and classification area in the construction compound. Surface water drainage from this area would be managed to prevent the potential for pollution of the water environment in line with current good practice methods.

16.5.11 It is anticipated that all materials that are suitable would be either reused on site transported by river or road to a suitable site such as Wallasea Island for inclusion in a wetland creation scheme being undertaken by the RSPB. The potential for impacts associated with the transport and disposal of spoil are discussed in Chapter 11: Effects on all Travellers.

16.5.12 A temporary jetty would be constructed to permit the operation of the proposed marine transportation system. The jetty would be constructed using hollow tubular steel piles embedded into the river bed. The assessment has been based on 600-700mm diameter piles and which be embedded at a 1/3 to 2/3 ratio in the river bed. Detailed jetty design would seek to minimise the potential for this structure to temporarily impact on the existing flow hydraulics and hydrodynamics of the River Thames, as demonstrated by the results of a hydrodynamic modelling study which has shown that the jetty causes only negligible changes in flow velocities around the structure, no effects on sediment transport and imperceptible effects on water levels in the river. In order to mitigate against the potential for increases in turbidity and scour during construction of the jetty, works would be undertaken in accordance with good practice methods for pollution control. Scour protection measures would be put in place. Further information is provided in Appendix 16.B.

Measures to prevent or reduce flood risk and drainage impacts

16.5.13 Temporary site drainage systems would be put in place to retain surface water runoff within the land to be acquired or used, where practicable.

16.5.14 Drainage systems would be inspected regularly and maintained as necessary to ensure they operate to the appropriate standard. Inspection and maintenance would be required more often in areas with a high level of construction activity.

16.5.15 The existing flood defences provide a high standard of flood protection from the River Thames. The tunnel element of the Scheme would pass beneath the river wall defences on both banks of the river and any impact on river wall foundations would be avoided. The tunnel will have a clearance of 4m beneath the river wall foundations on the southern portal and 5m of clearance from the river wall foundations on the northern portal.

16.5.16 The potential for an impact on the integrity of the flood defences protecting the Scheme and wider areas due to settlement would also be addressed. To minimise the impact of settlement, good tunnelling practice would be implemented including continuous working, erecting linings immediately after excavation, grouting, management of the tunnel face pressures and the measurement of excavated material quantities. Settlement monitoring would also be undertaken during the tunnelling works and would be carried out for a period of up to two years post construction. Good tunnelling practice and settlement monitoring would be specified within the DBFM contract.

16.5.17 Flood defence consent is required prior to undertaking any works within 16m of the banks of the River Thames or River Lea prior to undertaking the works.

Measures to prevent or reduce impacts on water resources

16.5.18 Water use efficiency and water re-use is to be advocated by a CEMP. For example, stored water collected by the drainage systems would be used for dust suppression and for other construction phase tasks, such as operation of the Tunnel Boring Machine. If required, pumps would be provided at each storage lagoon for use in filling water bowsers.

16.5.19 Water needed for site offices, canteens and laboratories would be taken from Thames Water mains piped potable supplies and measures to encourage water use efficiency would be adopted.

Operation

Measures to prevent or reduce water quality impacts

16.5.20 During the operation of the Scheme at the Silvertown site a pump would be used to discharge surface water runoff into the existing Thames Water sewer network. During the operation of the Scheme at the Silvertown site surface water runoff collected by the northern portal drainage network would be discharged into an existing watercourse (The Cut) and to existing Thames Water sewers. A Class 1 bypass petrol interceptor is to be provided to fully treat all flows generated by rainfall rates of up to 6.5mm/hour. This covers most rainfall events. Flows above this rate are allowed to bypass the interceptor. Manually operated penstock catch pits are required to provide a shutoff facility in the event of emergency major spillage. The spillage will be contained within an emergency impoundment facility for a containment volume of 25m^3.

16.5.21 During the operation of the Scheme to prevent the potential for pollution associated with a spillage in the tunnel, any spillage would be collected from the carriageways using a side entry kerb drainage system, with minimum travel along the carriageway. The spill would then travel to the main sumps, located at the low point of each bore. These facilities would be sized to accommodate the contents of a fuel tanker (approximately 30,000 litres).

16.5.22 During the construction phase of the Scheme works would be undertaken to provide a drainage system that is fit for purpose, there would be permanent benefits to the receiving water environment in terms of reduced siltation and improved drainage discharge quality.

Measures to prevent or reduce flood risk and drainage impacts

16.5.23 Cut-off drainage would be provided at the tunnel portals to prevent ingress of rainfall runoff from the approach roads into the tunnel. A drainage sump would be located at the tunnel portals which would provide an intercept and storage facility for collected surface water run-off, as well as a

reception chamber for water being pumped back from the low-point sump in the tunnel. Surface water run-off from within the bored section of the tunnel would be collected via gullies or a combined drainage kerb system and collected in the sump, from where it would be pumped to the northern portal service building compound where an impounding foul sump would be provided under the car park. This would then ultimately discharge to sewer or to the River Thames depending upon which is the most appropriate after taking into account factors such as discharge effluent quality. A second attenuation system, likely to take the form of oversized carrier drains or storage tanks, would be provided to store surface water runoff from the remaining catchment areas falling towards the portals. A flow-control device would control the outfall rate into the portal sump from the attenuation system.

16.5.24 SuDs are considered to represent a more sustainable approach to drainage than traditional piped systems. They can be used to reduce the rate of surface water runoff through attenuation of flows by storage and conveyance of surface water, as well as improve surface water quality. SuDs principals have been incorporated into the surface water system as far as is practically possible due to Scheme constraints and the SuDs measures included provide both flow attenuation and treatment.

16.5.25 The permeability of the floodplain alluvial layer, through which the tunnel would be bored, makes ground water infiltration into the tunnel a potential risk. This risk however, will be mitigated by design ensuring groundwater ingress to the bored tunnel is restricted. Further information on the measures that would be put in place to prevent and reduce impacts on hydrogeological receptors and resources are provided in Chapter 12: Geology and Soils.

16.5.26 A Flood Emergency Plan (16.C) has been produced, linked into the Environment Agency's advanced flood warning system, in order to manage the unlikely event of flooding on-site should a breach in the River Thames defences occur during the lifetime of the Scheme. The plan sets out evacuation procedures. This will need to be revised and updated by the DBFM contractor.

Recreation

16.5.27 The potential for any effect on the recreational facilities supported by waterbodies in the study area would be avoided by the measures to prevent pollution/water quality impacts outlined in paragraph 16.5.17. No additional mitigation measures are considered necessary.

16.6 Assessment of impacts

Construction impacts

16.6.1 The following section assesses the potential effects of the construction phase on the individual receptors identified in Table 16-6, taking into account the measures described in Section 16.4. A summary of residual effects is presented in Table 16-7.

16.6.2 This assessment should be considered in conjunction with related assessments presented in Chapter 12: Geology and Soils, Chapter 11: Effects on all Travellers and Chapter 10: Marine Ecology.

Water quality

16.6.3 There is a risk of pollution of the water environment associated with construction of the bored tunnel, portals, the local highway network and the temporary jetty. Accidental spillages of oil, chemicals and fuels from construction plant or storage facilities pose the greatest risk. Cement dust and concrete preservatives entering watercourses, through dust blow or in runoff, could also be detrimental to water quality and aquatic organisms. In addition there is a risk of sedimentation of surface waters associated with excavation and subsequent handling and storage of excavated material.

16.6.4 Once appropriate environmental design measures are in place, the potential for residual water quality effects on surface water receptors is restricted to the potential for localised contained spills and or silt releases, or mobilisation of ground contamination. The working practices that would be adhered to (as required by the CoCP and the CEMP) would limit these to minor incidents and allow rapid containment and clean up.

16.6.5 The residual significance of effect on the water quality attributes of surface water resources (ranging from High to Low sensitivity) is classified as

having a temporary **Negligible** magnitude of impact, with an overall residual significance of effect that is **Neutral.**

Flood risk

16.6.6 The northern and southern portals of the Scheme are located within defended Flood Zone 3, subject to a high residual risk of flooding from the River Thames. Scheme design is such that there would be no construction phase impact on the integrity of existing flood defences, for example, any impact on river wall foundations would be avoided and settlement from tunnel boring would be minimised and monitored. Therefore during the construction phase of the Scheme baseline standards (detailed in section 16.4.15) of fluvial/tidal flood protection would be maintained.

16.6.7 Hydrodynamic modelling of the temporary jetty has been undertaken and has shown that that jetty will not have a significant impact on flow velocities or sediment transport. The jetty would not impact on water levels in the river Thames so would not have an impact on flood risk.

16.6.8 The residual significance of effect on fluvial/tidal flood risk associated with the River Thames and the Bow Creek (High sensitivity) is classified as having a **temporary Negligible** magnitude of impact, with an overall residual significance of effect that is **Neutral**.

16.6.9 The bored tunnel and cut and cover approaches will be constructed through the superficial geology (alluvium and river terrace gravels) and may intercept groundwater in the deeper Thanet Sands/Chalk aquifer (tunnel only) such that there is potential for ground water ingress during construction. This risk however, will be mitigated by design such that the magnitude of groundwater flood risk impact is classified as **Minor,** with an overall residual significance of effect that is **Slight Adverse**.

Land drainage

16.6.10 The majority of the Scheme is located in an area of '*very low*' surface water flood risk (less than 1 in 1000 chance). There are some small isolated areas where the Scheme is at low (between 1 in 1000 and 1 in 100 chance), medium (between 1 in 100 and 1 in 30 chance) and high (greater than 1 in 30 chance) risk of surface water flooding.

16.6.11 Existing land drainage is facilitated by an integrated network of combined sewers and highway drainage infrastructure that is maintained by Thames Water and that ultimately discharge into the River Thames. During the construction phase of the Scheme works would be undertaken to provide a drainage system which would improve surface water drainage.

16.6.12 The residual significance of effect on surface water risk, mitigated by construction phase drainage design, is classified as having a **Negligible** magnitude of impact for the majority of the study area, with a **Minor Beneficial** magnitude of impact at the Silvertown site, having an overall residual significance of effect that is **Neutral**.

Water resources

16.6.13 During the construction phase an additional temporary demand on water resources would result from the need to supply site offices, canteens and welfare facilities. However, it is understood that this will be minimalised due through effective water efficiency measures. In addition water would be needed for use in tasks such as operation of the Tunnel Boring Machine and dust suppression. Due to the measures proposed for water re-use and water use efficiency the increase in demand on Thames Water resources (mains water supplies) would be relatively minor.

16.6.14 The residual significance of effect on surface water resources during the construction phase is classified as having **temporary Minor adverse** magnitude of impact; with an overall residual significance of effect that is **Neutral**.

16.6.15 The construction phase of the Scheme is not considered to have the potential to affect the integrity of existing surface water abstractions, which are all located in excess of 1km for any works sites. No effects on existing consented discharges are anticipated, as it is also considered that the construction phase would not affect the ability of watercourses to transport and dilute waste water discharges so no effects on existing consented discharges are anticipated. The magnitude of the residual impact on waste dilution/transport and water supply during the construction phase is classified as **temporary Negligible**; with an overall residual significance of effect that is **Neutral**.

Recreation

16.6.16 The River Thames and the Victoria Dock both support water-based recreational facilities that depend on maintaining appropriate water quality standards. The measures outlined above to manage construction phase water quality impacts would reduce the potential for impacts on water based recreation in the study area.

16.6.17 The magnitude of the residual impact on recreational attributes of the River Thames and Victoria Dock during the construction phase is classified as temporary **Negligible**, with an overall residual significance of effect that is **Neutral**.

Operational impacts

Water quality

16.6.18 Once the construction phase is complete, the risks of a pollution incident arising from heavily silted runoff and fuels, oils and other chemicals would be reduced to significantly less than the risks associated with the construction phase. The Scheme itself would be designed to ensure pollution control during operation and class 1 bypass petrol interceptors and spill tanks will be used to fully treat flows.

16.6.19 Therefore, the magnitude of the residual impact on the water quality attributes of surface water resources (ranging from High to Low sensitivity) is classified as **Negligible**, with an overall residual significance of effect that is **Neutral**.

Flood risk

16.6.20 The tunnel would be bored beneath the River Thames and there would be no impediment to the natural flow regime of the river during the operational phase of the Scheme. However, a FRA has highlighted that over the lifetime of the Scheme, as a result of the predicted impact of climate change, the current high standard (1 in 1000 year) of flood protection would not be maintained, resulting in increased flood risk to the tunnel approaches and the tunnel itself, from overtopping and breach of existing defences.

16.6.21 Current defences (5.18m AOD) are generally sufficient to prevent overtopping to the year 2065, though with very little remaining freeboard. During the 2065-2100 period defences will therefore need to be upgraded as outlined in Thames Estuary 2100 Plan (TE2100). A River Wall Condition Survey (Appendix 16.D) undertaken in 2015 concluded that all sections of river wall have the potential to support future raising. Methods could include raising existing concrete parapets, constructing concrete capping beams on existing sheet piles and constructing new flood walls directly onto existing concrete abutments. Construction of the Scheme would not prevent nor limit the available options for future defence raising works.

16.6.22 Scheme design would mitigate the risk of flooding from groundwater ingress and also ensure that surface water runoff from the Scheme is managed such that there would be no increase in flood risk from these sources and an effect that has an overall **Neutral** significance.

16.6.23 Therefore, the magnitude of the residual impact of the Scheme on flood risk (High to Low sensitivity) to third parties is classified as **Negligible**, with an overall residual effect with a significance that is **Neutral**. The Scheme itself is at a residual risk of flooding should a breach in the Thames defences occur, however this risk would be managed by putting in place a Flood Warning and Evacuation Plan. Flood conditions in the study area in the highly unlikely event of a defence breach are being quantified by a bespoke breach modelling study that is underway. The results of this modelling will be incorporated into the final ES and will be used to inform and update the Flood Warning and Evacuation Plan.

Water resources

16.6.24 Once the construction phase is complete the demand on water resources will be reduced from that associated with the construction phase, with water use associated with periodic tunnel cleaning and a supply of water required for firefighting.

16.6.25 Water for use in firefighting would be stored in a dedicated tank that would have an automatic top up from mains water supply if required.

16.6.26 The magnitude of the residual impact on surface water resources during operation is classified as temporary **Negligible** with an overall effect having a residual significance that is **Neutral.**

16.6.27 The operational phase of the Scheme is considered to have no potential to affect the integrity of existing surface water abstractions, which are all located in excess of 1km from the Scheme. It is also considered that the operational phase would not affect the ability of watercourses to transport and dilute waste water discharges so no effects on existing consented discharges are anticipated. The magnitude of the residual impact on waste dilution/transport and water supply during operation is classified as **Negligible**; with an overall effect having a residual significance that is **Neutral**.

Recreation

16.6.28 Once the construction phase is complete, there will be no impact on the recreational attributes of surface waters within the study area.

16.6.29 Therefore, the magnitude of the residual impact on water based recreational resources is classified as **Negligible**, with an overall effect that has a residual significance that is **Neutral**.

16.7 Cumulative impacts

16.7.1 As illustrated in Drawing 17.2 Cumulative developments, within 1km of the land to be acquired or used there are numerous committed and planned developments. Many of these developments have the potential to influence water environment receptors common to the Scheme and the potential for cumulative impacts has therefore been assessed and is outlined below.

16.7.2 All committed or planned developments would be expected to be subject to stringent construction phase pollution prevention control measures, such that there would be no cumulative temporary impacts on the water quality of local waterbodies that have the potential to receive runoff from construction work areas.

16.7.3 During their operational phases the developments will be required to comply with policies, for example, those set out in the London Plan, which

encourage adoption of sustainable drainage systems (SuDS) and require that surface water drainage systems are designed to achieve betterment (i.e. a reduction in existing rates and volumes of runoff). Adoption and compliance with these policies will therefore result in a cumulative beneficial impact in terms of decreasing inflows to the existing sewer network and reducing surface water flood risk across the study area. There is also potential for SuDS to deliver higher quality discharges, with potential for a cumulative net benefit in terms of an improvement in the quality receiving waterbodies.

16.7.4 All committed or planned developments will be also be subject to compliance with NPPF and Environment Agency requirements regarding demonstration of the appropriateness of the River Thames defences to provide protection to the required TE2100 future standards over their respective development lifetimes.

16.7.5 It is concluded that there is potential for **Moderate Beneficial** cumulative effects on the water quality and flood risk related attributes of water environment receptors within the study area.

16.7.6 Effects on recreational users of the water environment have been assessed as having an overall **Neutral** significance. Construction and operation of the Scheme is considered to have no potential to affect the integrity of existing water abstractions or discharges. Additional temporary demands on water resources in order to supply key construction processes and welfare facilities during the construction phase would be mitigated by efficient water use measures and water reuse where feasible.

16.8 Further work to be done

16.8.1 Bespoke breach modelling of the Scheme is being undertaken and the results of this will be incorporated into the final ES.

16.8.2 A full WFD Assessment and bespoke dredging impact study will also be undertaken with the results incorporated into the final ES.

16.8.3 Consultation has been undertaken with the Environment Agency regarding licensing and permitting requirements. It has been advised that certain construction activities would be subject to Flood defence consent (all works within 16m of an existing flood defence) and that permits and

consents will also be required for dewatering and subsequent discharge of these waters. The Environment Agency have advised that the consent/permit applications should be informed by detailed design information and that application for these consents and permits would be better made outside of the DCO. It has also been noted that any works below MHWS, such as for construction of the temporary jetty, would require a marine licence from the Marine Management Organisation.

16.9 NN NPS compliance

16.9.1 The NN NPS (Ref 16-2) sets out the need for, and Government's policies to deliver, development of nationally significant infrastructure projects (NSIPs) on the national road and rail networks in England. The NN NPS supports the NPPF and explains that essential transport infrastructure is permissible in areas of high flood risk, subject to satisfaction of the NPPF Exception Test.

16.9.2 Flood risk to the Scheme and the potential for the Scheme to impact on flood risk to others has been assessed, using a combination of Environment Agency data and bespoke hydraulic modelling. The FRA that has been produced (Appendix 16A) concludes that, through design and the operation of a Flood Warning and Evacuation Plan, the Scheme will remain safe in times of flood and that there will be no increase in flood risk to third parties.

16.9.3 It is understood that at the Silvertown site the existing drainage systems are failing, resulting in pollution of the water environment. Construction of Silvertown tunnel will involve removing all of these polluting land uses and introduce new drainage across the site. The Schemes drainage system would be based on the principles of attenuated and treated discharge. Provision would be made to provide a storage facility at the limiting discharge rate for a 1 in 100 year critical duration storm including an appropriate allowance for climate change. The Schemes Drainage system will not increase surface water flood risk and improve the quality of drainage discharges to receiving waters, namely the Cut and the River Thames.

16.9.4 The scheme is understood to be flood resilient and the current flood defences are sufficient to prevent overtopping to the year 2065. During

the 2065-2100 period defences will therefore need to be upgraded as outlined in Thames Estuary 2100 Plan (TE2100). The Scheme is therefore considered to achieve compliance with this aspect of the NN NPS.

16.10 Summary

16.10.1 An assessment has been undertaken of the effects of the Scheme on the local water environment. This covered the potential for effects upon hydrology, hydrological receptors, flood risk and surface water drainage.

16.10.2 Environmental design measures have been incorporated into the Scheme to prevent or minimise adverse effects on the water environment.

16.10.3 The potential effects, without environmental design measures, on water quality during the construction phase would arise from normal construction activity that has the potential to generate contaminated surface water runoff. Once appropriate measures are in place, including good practice site management practices, it is considered that there would be a **Negligible** magnitude of change to the water quality of receptors and an impact having overall **Neutral** significance.

16.10.4 Both the Silvertown and Greenwich sites are classed as being in an 'Area Benefitting from Defences' (ABD), which reduce the actual flood risk to the Scheme. Existing standards of flood protection and the existing requirements for flood protection will remain unchanged during the construction period, therefore and as a result the magnitude of the impact on fluvial/tidal flood risk during construction is considered to be **Negligible**, with an effect having an overall **Neutral** significance. However, the current flood defences are lower than the future 2100 predicted water levels, a period during which the Scheme will operate. As a result, if the defences are not raised to the proposed levels set out in the TE2100 plan, there is potential for future overtopping of the defences. The Scheme will not prohibit the raising of the defences in the area around the Scheme. The Scheme defences have been assessed and are considered to have sufficient structural integrity to withstand being raised in the future,

16.10.5 Hydrodynamic modelling for the Silvertown jetty has been undertaken and has shown that that jetty will not have any significant impacts on the existing flow or sediment transport regimes of the River Thames.

16.10.6 The Scheme is generally at low risk of surface water flooding and currently drains to existing highway and combined sewer systems that are maintained by Thames Water. During the construction phase of the Scheme, works would be undertaken to provide an improved drainage system. It is considered that this would result in a **Minor Beneficial** magnitude of impact to the water quality of The Cut with an effect having overall **Neutral** significance.

16.10.7 Effects on recreational users of the water environment have been assessed as having an overall **Neutral** significance and construction and operation of the Scheme is considered to have no potential to affect the integrity of existing water abstractions or discharges. Additional temporary demands on water resources in order to supply key construction processes and welfare facilities etc. during the construction phase would be mitigated by adopted water use efficient measures and water reuse where feasible.

16.10.8 In conclusion, based on the information available to date, there are considered to be no effects on water environment receptors that would be considered significant during the construction or operational phases of the Scheme.

Table 16-7 Water environment significance summary table

Receptor		**Construction**		**Operation**	
		Sensitivity	**Residual Significance of Effect**	**Sensitivity**	**Residual Significance of Effect**
River Thames Estuary	Water Quality	**High**	Neutral	**Medium**	Neutral
	Flood Risk	**High**	Neutral	**High**	Neutral
	Water resources – water supply	**Low**	Neutral	**Low**	Neutral
	Water resources – transport/ dilution of wastes	**High**	Neutral	**High**	Neutral
	Recreation	**Medium**	Neutral	**Medium**	Neutral
River Lea (Bow Creek)	Water Quality	**Medium**	Neutral	**Medium**	Neutral
	Flood Risk	**High**	Neutral	**High**	Neutral
	Water resources – water supply	**Low**	Neutral	**Low**	Neutral
	Water resources – transport/ dilution of wastes	**High**	Neutral	**High**	Neutral

Receptor		**Construction**		**Operation**	
		Sensitivity	**Residual Significance of Effect**	**Sensitivity**	**Residual Significance of Effect**
Royal Victoria Dock	Water Quality	**High**	Neutral	**High**	Neutral
	Flood Risk	**Low**	Neutral	**Low**	Neutral
	Water resources – water supply	**Low**	Neutral	**Low**	Neutral
	Water resources – transport/ dilution of wastes	**Low**	Neutral	**Low**	Neutral
	Recreation	**Medium**	Neutral	**Medium**	Neutral
The Cut	Water Quality	**Low**	Neutral	**Low**	Neutral
	Flood Risk	**Low**	Neutral	**Low**	Neutral
	Water resources – water supply	**Medium**	Neutral	**Medium**	Neutral
	Water resources – transport/ dilution of wastes	**Low**	Neutral	**Low**	Neutral
Unnamed watercourse in	Water Quality	**Low**	Neutral	**Low**	Neutral

Receptor		**Construction**		**Operation**	
		Sensitivity	**Residual Significance of Effect**	**Sensitivity**	**Residual Significance of Effect**
Southern portal study area	Flood Risk	**Low**	Neutral	**Low**	Neutral
	Water resources – water supply	**Low**	Neutral	**Low**	Neutral
	Water resources – transport/ dilution of wastes	**Low**	Neutral	**Low**	Neutral