



# RIVER CROSSINGS: SILVERTOWN TUNNEL

## SUPPORTING TECHNICAL DOCUMENTATION

### SILVERTOWN TUNNEL OPTIONS STUDY

Hyder Consulting

November 2013

This report describes the baseline conditions in the vicinity of the proposals, identifies the environmental risks associated with the proposed tunnel options and assesses the overall deliverability of each option. Two separate comparisons have been undertaken:

- Bored 'Base' option vs Immersed Tube 'Base' option
- 'Base' options vs Shortened (B and C) options

This report is part of a wider suite of documents which outline our approach to traffic, environmental, optioneering and engineering disciplines, amongst others. We would like to know if you have any comments on our approach to this work. To give us your views, please respond to our consultation at [www.tfl.gov.uk/silvertown-tunnel](http://www.tfl.gov.uk/silvertown-tunnel)

Please note that consultation on the Silvertown Tunnel is running from October – December 2014



Transport for London

River Crossings

Environmental Services Consultancy

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Silvertown Tunnel Options Study, November 2013



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# Transport for London

## River Crossings

### Environmental Services Consultancy

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#### Silvertown Tunnel Options Study

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# 1 Introduction and Background

The Mayor's Transport Strategy (MTS) identifies the need to improve river crossings in East London. Historically there have been fewer river crossings in East London than in the west due to the width of the river, the types of land use and the presence of shipping activity east of Tower Bridge. This has resulted in limited interaction between residential population and businesses either side of the river in east and south-east London. Furthermore the limited existing river crossings in East London have insufficient capacity, poor reliability and resilience, ageing infrastructure and a lack of suitable alternatives routes.

The London Plan describes the need for substantial growth in population and employment to maintain and build on the capital's global economic position over the next two decades. The majority of this planned growth is earmarked for east London and the Thames Gateway area with a number of key Growth and Opportunity Areas. Hence the limitations and operational problems identified above are likely to create a significant constraint on these growth and development aspirations in east and south-east London.

In response to the above drivers, Transport for London (TfL) embarked on the East London River Crossings Programme in 2009 with the key elements contained in MTS Proposal 39 and set out below:

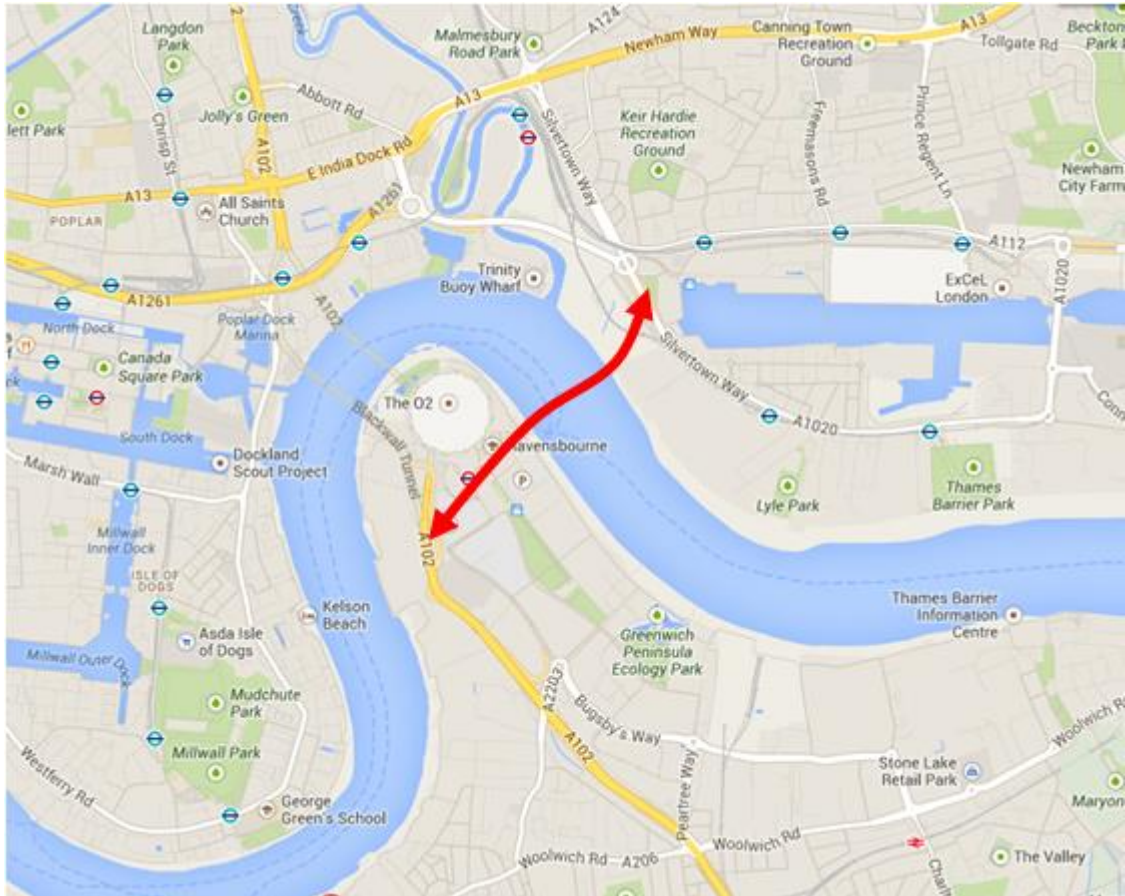
- A new fixed link at Silvertown to provide congestion relief to Blackwall Tunnel and provide local links for vehicle traffic
- Replacement of Woolwich Ferry including longer-term fixed link options at Gallions Reach
- Enhanced local links for pedestrians and cyclists – delivered by Emirates Air Line Cable Car (June 2012)
- Encouragement of modal shift from private cars to public transport (using new rail links including High Speed 1 (HS1), Crossrail and DLR extension)

This Options Study Report concerns the first element of the Proposal, which involves a new road tunnel between Silvertown and north Greenwich which will provide an alternative route between the Royal Docks, Isle of Dogs, Lower Lea Valley and Greenwich Peninsula.

## 1.1 Site location

The new river crossing will provide a dual two lane connection between the A102 on Greenwich Peninsula and the Tidal Basin roundabout on Silvertown Way. The location of the proposed tunnel river crossing is provided in Figure 1-1.

Figure 1-1 Location of the Scheme



The northern side of the Scheme is located within the London Borough of Newham and the southern side is located within the Royal Borough of Greenwich.

## 1.2 Options Description

The tunnel would pass under the River Thames, inside an area of land that has been safeguarded for this purpose.

The twin bored tunnels would be designed with a circular cross section, and would be connected by pedestrian cross passages to facilitate intervention in an emergency. The immersed tunnel is a single unit rectangular in cross section; with three compartments (two carriageways plus a central gallery for services/escape). The width of the immersed tunnel structure is less than the twin bored tunnel solution.

Eight options are being considered in terms of design and engineering details and a short description of each option is presented in Table 1-1. The table below discusses which of these proposed options are considered further in this Options Study Report.

**Table 1-1 Options description**

Tunnel Type	Option No.	Variant	Details	Consideration in the Options Study Report
Immersed Tube	'Base'	Original long option with on-site casting.	<p>The immersed tunnel structure is a reinforced concrete three cell box structure. The total immersed length between the approach cut and cover tunnels is 488m. This length is subdivided into four tunnel elements, each with an equal length of 122m. The immersed tube tunnel has a shallower vertical alignment when compared with the bored tunnel. The vertical alignment of the tunnel has been developed by setting the top of the tunnel roof as a depth of 1.5m below the river bed at the low point of the tunnel.</p> <p>The immersed tunnel is formed from four tunnel elements that are constructed in a purpose built casting basin. A cutting is excavated using cofferdams across the Thames and then the tunnel sections are dropped in and then back filled. The safeguarded area to the east of the Emirate Airline Cable Car on the Silvertown approach was originally chosen for a casting basin location, but other options are also being considered.</p> <p>The length of cut and cover construction is 552m on the Greenwich approach and 341m on the Silvertown approach. (Drawing MMD-298348-TUN-301).</p>	Considered in this Options Study Report.
Immersed Tube	A	Original long option with off-site casting.	Same as the 'Base' option, but the purpose built casting basin will be located off-site.	Impacts of this option would be similar to those of the 'Base' option, except for the impacts associated with the casting location site and transport. Since there is currently no information on where this would be located, we have not considered this option in the options comparison at this environmental assessment stage.
Immersed Tube	B	Shortened option with on-site casting	Northern end is exactly the same as the 'Base' immersed tube option, but at the southern end the tunnel portal is located closer to the river. The exit road then runs above ground rather than in a cut-and-cover tunnel. It will involve some realignment of the Millennium Way to gain the necessary headroom (see Drawing MMD-298348-C-DR-00-ZZ-1060_P1)	Considered in this Options Study Report.

Tunnel Type	Option No.	Variant	Details	Consideration in the Options Study Report
Immersed Tube	A+B	Shortened option with off-site casting	Same as option B, but the purpose built casting basin will be located off-site.	As for Option A – not considered.
Bored	'Base'	Original long option with cross-passages at 350m spacing	<p>The design comprises twin 11.0m internal diameter, 1.0km long bored tunnels, with cross passages for evacuation at maximum 350m centres with cut and cover tunnel approaches. The bored tunnel approaches comprise open cut ramp and cut and cover tunnels at either end of the bored tunnels. The side walls will be constructed as diaphragm walls or secant piled walls.</p> <p>The cut and cover box depths vary but at their shallowest they are approximately 10m deep. The temporary lateral ground loads during construction will be considerable. It is generally assumed that all boxes will be constructed bottom up but some may be constructed top down, but there will be sections which need to be left open to facilitate tunnel boring machine (TBM) operations and these will of necessity be constructed bottom up to allow craneage access during tunnelling. Temporary steel props and/or ground anchors will be needed (see Drawing MMD-298348-C-DR-00-ZZ-1004).</p>	Considered in this Options Study Report.
Bored	C	Shortened option with cross-passages at 350m spacing	Northern end is exactly the same as the 'Base' bored tunnel option, but at the southern end the tunnel portal is located closer to the river. The exit road then runs above ground rather than in a cut-and-cover tunnel. It will involve some realignment of the Millennium Way to gain the necessary headroom (see Drawing MMD-298348-C-DR-00-ZZ-1050_P1).	Considered in this Options Study Report.
Bored	D	Shortened option with cross-passages at 100m spacing	Same as option C, but with cross passages for evacuation at maximum 100m spacing.	Not considered in this options comparison as it is anticipated that the environmental risks will be similar to option C.
Bored	E	Original long option with cross-passages at 100m spacing	Same as 'Base' option, but with cross passages for evacuation at maximum 100m spacing.	Not considered in this options comparison as it is anticipated that the environmental risks will be similar to the 'Base' option.

## 1.3 Aims of the report

The purpose of this report is to identify the environmental risks associated with the proposed tunnel options and to assess the overall deliverability of each option. As identified in Table 1-1, this Options Study Report focuses on four of the options that are being considered for the proposed Silvertown tunnel. The report describes the baseline conditions in the vicinity of the proposals, and provides a high level comparison of the environmental risks that could arise from each of these four options. Two separate comparisons will be undertaken:

- Bored 'Base' option vs Immersed Tube 'Base' option
- 'Base' options vs Shortened (B and C) options

Chapter 2 provides details of the approach taken to assess and compare the potential environmental risks of each option as well as the scope of the assessment.

Chapter 3 describes the baseline conditions in the vicinity of the proposed tunnel options.

The high level assessment and comparison of the environmental risks of each option is presented in Chapter 4. Where major environmental risks are identified, mitigation measures are suggested to avoid/reduce any environmental risks, and comments are provided on the deliverability of each option from an environmental perspective.

## 2 Methodology

### 2.1 Baseline collection

A high-level baseline study has been undertaken based on publically available (e.g. web-based) data sources.

A number of other data sources have been made available:

- Silvertown Crossing Study, Tunnel Engineering Report (Mott Macdonald) June 2012
- Silvertown Tunnel Further Development of Tunnel Engineering (Mott MacDonald) July 2013
- Silvertown Tunnel, Tunnel Engineering, Addendum A (Mott MacDonald) October 2013
- Emirates Air Line Cable Car EIA (Mott MacDonald) 2010
- New Thames River Crossing Sustainability Report (TfL) December 2009

Further data collection would be undertaken prior to any formal Environmental Impact Assessment for the selected option, but it is not appropriate to undertake this level of study at this stage.

The study area covers the safeguarded area for the Scheme including the area adjacent to the Scheme (up to 1km) and is shown on Drawing 6.2-UA005651-UE31D.

### 2.2 Options comparison

Four tunnel options have been considered in this Options Study Report (see Table 1-1). A high-level comparison of the impacts has been undertaken, appropriate to the stage of this study and the level of baseline data available. Environmental risks have been identified for each of the four tunnel options taking into consideration the following:

- Location of the Scheme including baseline conditions for each environmental topic
- Vertical and horizontal alignment of each tunnel option
- Design criteria
- Construction methodology
- Number and sensitivity of receptors
- Potential to mitigate any major environmental risks
- Potential environmental risks associated with the operation of the Scheme

The environmental risks are then compared and the overall deliverability is assessed for each option (including potential mitigation measures) and provided as part of the environmental assessment at this stage. In order to provide some degree of indication of the level of risk for each option, a scale of absolute potential risks is provide in Chapter 4. Any uncertainties and technical limitations of assessment are presented in Section 2.4 of this report.

## 2.3 Scope

The environmental risks are presented in a comparative manner for each environmental topic. The scope of this study comprises the following environmental topics:

- Air Quality
- Community and Private Assets
- Cultural Heritage
- Ecology and Nature Conservation
- Effects on All Travellers
- Geology and Soil
- Materials
- Noise and Vibration
- Townscape and Visual Impact
- Water Environment

Once an option has been selected for progression, further environmental studies and consultation would be undertaken to refine and select a final scheme. This would lead to the preparation of an Environmental Statement in accordance with Directive 85/337/EEC (as amended).

## 2.4 Uncertainty and limitations

During the options comparison it was recognised that uncertainty exists with regards to the prediction of magnitude and significance of potential adverse impacts. This is due to the level of baseline data available at this stage of environmental assessment as well as scheme details. In addition, the exact location of the casting basin with the immersed tube options is still uncertain and more detailed assessment of the off-site options may be required once a site location has been selected.

Additional survey work and further environmental consultation at the next stages of assessment will further increase the knowledge of the area and help determine the magnitude and significance of any environmental risks.



## 3 Baseline Description

### 3.1 Air Quality

Part IV of the Environment Act 1995 requires local authorities to review current and future air quality within their areas, and declare Air Quality Management Areas (AQMA) where it is anticipated that an air quality objective will not be met. The study area contains a large number of AQMAs and therefore the baseline air quality is likely to be poor and exceeding Air Quality Strategy Objectives/European Union Limit Values.

The London Borough of Newham has identified a number of AQMAs throughout the borough. Of particular relevance to the Scheme is the AQMA designated along the A1020 Silvertown Way which is declared for exceedences of Nitrogen Dioxide (NO<sub>2</sub>) and Particulate Matter (PM10) levels.

The Royal Borough of Greenwich has also identified a number of AQMAs throughout the borough. Of particular relevance to the Scheme is the AQMA designated along the A102 Blackwell Tunnel Approach in the south western section of the study area. This has been declared for exceedences of NO<sub>2</sub> and PM10 levels. The A102 corridor divides the peninsula and is a significant source of noise and air pollution (see Drawing 5.1-UA005651-UE31D).

### 3.2 Community and Private Assets

A high level desk study has been undertaken to determine the baseline conditions associated with the safeguarded area of the proposed options. Local planning documents issued by the London Borough of Newham and Royal Borough of Greenwich have also been reviewed, as they include details for sites allocated for development in the vicinity of the Scheme. All of this information has therefore been used to inform the baseline description provided below.

Plans identifying land required for construction of the tunnel options have been produced following a review of their alignment and configuration. The land required has been confined to the currently defined safeguarding boundary. The safeguarded area is shown on Drawing 6.2-UA005651-UE31D. The site includes Thames Wharf, Alexandra Wharf and Royal Victoria Dock to the north of the Thames and the area around Edmund Halley Way on the Greenwich Peninsula on the southern side of the Thames.

#### 3.2.1 Land Use

The northern portal lies in the London Borough of Newham. The current development plans for the area focus on the Silvertown Quays to the east of Silvertown Way for mixed residential and commercial development. Mixed residential and recreational land uses dominate around the perimeter of the Royal Victoria Docks and light commercial uses to the south of the elevated Silvertown Way and the DLR. There are plans for properties within the safeguarded area at Silvertown to become listed and that could potentially limit the safeguarded area available.

The southern tunnel portal sits on the Greenwich Peninsula in the Royal Borough of Greenwich. On the southern side of the River Thames, the land use is predominantly car parking with the O2 Arena and commercial buildings located to the northwest and a leisure facility to the south east. The majority of the land on the Peninsula is owned by Greater London Authority (GLA). A gas holder (approximately 75m in diameter) is currently situated between Millennium Way and the Blackwall Tunnel Southern Approach on the western boundary of the Scheme. This is located in relatively close proximity of the highway realignment works.

The safeguarded area encompasses some areas of industrial buildings on both the northern and southern sides of the River Thames. The area is still classed as relatively deprived although it is likely to see significant population change as development continues.

### 3.2.2 Community facilities

Areas of public open space are limited to Central Park on the Greenwich Peninsula, which has been designated as 'Metropolitan Open Land' (MOL). There are also five parks/recreation grounds within 1km of the Scheme:

- Kier Hardie Recreation Ground
- Lyle Park
- Mudchute Farm
- Milwall Park
- St John's Park

The following education facilities are located within 1km of the Scheme:

- Britannia Village Primary School
- Hallsville Primary School
- St Luke's Primary School
- Millennium Primary School
- Ravensbourne University
- Cubitt Town Junior School
- St Luke's Church of England Primary School

The following medical facilities lie within 1km of the Scheme:

- Island Medical Centre
- PSU Surgery
- Custom House Teaching & Training Practice
- The Practice Britannia Village
- Greenwich Peninsula Practice

The only community centre in the study area is Island House Community Centre located on the Northern bank of the Thames. There are two cinemas on Greenwich Peninsula: one located in the O2 Arena to the west of the Scheme and one located to the south of the Scheme between Bugsby's Way and A102.

### 3.2.3 Land Allocated for Development

There is a significant amount of development proposed in close proximity of the Scheme on the north side of the river which would require consideration when identifying sensitive receptors likely to be affected from impacts associated with the tunnel options.

The Newham Core Strategy (London Borough of Newham, 2012) identifies areas for intensive development on the north bank of the River Thames. Areas for development include:

## Silvertown Quays

This is a residential-led mixed use development with potential for leisure and hospitality and green industries including research and development, building on the visitor attraction cluster at the western end of the docks (ExCeL, Siemens building). New residential development on this site will form part of the wider neighbourhood at Silvertown, supported by local shopping and community uses (a new local centre) focused around North Woolwich Road, including use of space under the DLR viaduct. Leisure uses should relate to the water space, with clear pedestrian and cycle connections through to the new local centre and across North Woolwich Road. Public access to the dock edge will be provided. Indicative residential typology - medium density, medium family.

## Minoco Wharf (Royal Docks)

The release of land designated as a Strategic Industrial Location (SIL) at Thameside West up to the eastern boundary of Lyle Park, and west of Lyle Park adjacent to North Woolwich Road, (18 ha) will assist in the development of a new neighbourhood at West Silvertown. Development will include pedestrian and cycle access to the river. Indicative residential typology – medium density, medium family.

## Thames Wharf

There is scope to reconfigure the safeguarded wharf on the site to the adjacent site (Carlsberg-Tetley) or to remove the wharf safeguarding at Thames Wharf if a consolidated wharf can be delivered at Thameside West subject to there being no net loss of functionality or wharf capacity. If it can be demonstrated that either scheme can be delivered, this could provide the opportunity to develop new employment, leisure/ tourism and residential uses grouped around a potential new DLR station where passive provision is in place, subject to addressing the constraints on the site, including the Silvertown Crossing safeguarding area, and the removal of the wharf safeguarding by the Secretary of State. Indicative residential typology - medium density, medium family.

## Royal Victoria West

New residential, leisure and cultural uses will be supported at this gateway site to the Royal Docks. The Siemens Crystal Building and Cable Car link to Greenwich Peninsula that opened in 2012 provide new visitor attractions. Public realm improvements, including an enhanced pedestrian and cycle link to Canning Town, and active water space, are key priorities in this location. Indicative residential typology - medium density, low family.

The Greenwich Peninsula on the south side of the River Thames is an area set for intense development to high environmental standards. 10,000 homes plus offices and public spaces have been proposed. Some elements of the development are within close proximity to the Scheme safeguarded boundary. The Peninsula Masterplan envisages the development of a new entertainment/sports complex to the west of the Blackwall Tunnel Approach with a mixed development of high quality commercial and residential properties throughout the peninsula.

## 3.3 Cultural Heritage

For the purposes of this report data on the baseline Cultural Heritage resources have been gathered from the Ground Investigation desk study carried out at the safeguarded area by Mott MacDonald in 2013. A review of publicly available information from English Heritage has also been undertaken to identify designated heritage features surrounding the tunnel safeguarded area.

The site within the safeguarded area has been in use since 1868 and has a legacy of industrial use. The two sides of the river have a similar industrial history. The northern part of the area encompasses the Royal Victoria Docks, including the historic Western Entrance to the docks which was closed in 1957. The docks are a key feature in the historic development of this area of London.

The southern part of the site is also industrial in nature and was dominated by a gasworks until 1987. From the 1990s onwards redevelopment of the site included extensive remediation to make it suitable for residential, commercial and industrial uses. This area is now dominated by the O2 Arena.

The London Archaeological Archive and Research Centre (LAARC) identifies four archaeological investigations which have been carried out within approximately 500m of the Scheme. The findings of the previous archaeological investigations indicate that there is the potential for the safeguarded area to contain remains relating to flood events and human activity in the prehistoric period and the industrial development of the area from the post-medieval period onwards. The study area is located in an area of East London which is known to have been heavily bombed during the Second World War (WWII).

The Heritage List for England identifies 14 listed buildings within 1.5km of the Scheme. This includes a number of structures associated with the Royal Victoria Docks including warehouses, grain silos and a number of cranes on the dockside. The review of publicly available information (English Heritage) has identified the presence of following listed buildings within 500m of the Scheme shown on Drawing 6.3-UA005651-UE31D:

- The Grade II Listed Southern Ventilation Shaft to the Blackwall Tunnel Southbound of 1967
- The Grade II Listed entrance to the Blackwell Tunnel
- A row of eight Grade II Listed Georgian cottages at Nos. 70-84 River Way

There are no listed structures or properties within the proximity of the safeguarded area on the northern side of the river. The London Borough of Greenwich designates the area immediately adjacent to the banks of the River Thames on the Greenwich Peninsula an Archaeological Priority Area (APA). On the northern side of the river the entire safeguarding area is located within an APA, designated by the London Borough of Newham that extends to the centre of the River Thames.

Approximately 1.5 km to the south west of the Scheme is the boundary of the World Heritage Sites (WHS) of Maritime Greenwich and the Scheduled Greenwich Palace.

## 3.4 Ecology

A high level desk study has been undertaken to determine the baseline conditions associated with ecology and nature conservation in the vicinity of the proposed options. In addition, a tunnel engineering report commissioned by the Mott MacDonald (July 2013) and environmental studies undertaken for the Emirates Air Line Cable Car EIA have also been reviewed, as they include some ecological baseline analysis. All of this information has therefore been used to inform the baseline description provided below.

### 3.4.1 Designated Sites

The Scheme is not situated within or immediately adjacent to any international or national designated sites for nature conservation. The nearest designated sites are:

- Lee Valley Special Protection Area (SPA) (approximately 8km north west of the Scheme boundary)
- Thames Estuary and Marshes SPA and Ramsar (approximately 15km east of the Scheme)
- Epping Forest Special Area of Conservation (SAC) ( approximately 7km north of the Scheme)

Whilst the tunnelling report identified that the Scheme lies within two kilometres of one Local Nature Reserve (LNR) and 16 non-statutory Sites of Importance for Nature Conservation (SINC), none of these sites will be directly affected. The closest SINCS to the Scheme are as follows:

- The River Thames and Tidal Tributaries SINC (this includes the areas of mudflat within the safeguarded area)
- Greenwich Peninsula Ecology Park SINC (an area of freshwater habitat approximately 0.5km south east of the southern part of the Scheme)
- Bow Creek Peninsula Ecology Park SINC (an area of meadow, pond and stream habitat approximately 0.8km north west of the northern part of the Scheme)
- East India Dock Basin SINC (an area of mud and saltmarsh habitat approximately 0.5km west of the northern part of the Scheme)
- Royal Docks SINC (an area of open water linked to the River Thames and its tidal creeks, located approximately 0.2km east of the northern part of the Scheme).

### 3.4.2 Habitats and Protected Species

The area required for the construction of the southern (Greenwich) end of the Scheme largely comprises paved areas, including the Blackwall Tunnel Approach to the west, Millennium Way to the east, the Gasometer site to the south and an industrial site to the north. However, it does include an area of derelict land that appears to be heavily overgrown with a mixture of small trees and scrub. This is one of the only patches of such habitat on the Greenwich Peninsula, and has been identified on Natural England's website as 'deciduous woodland', a Biodiversity Action Plan (BAP) habitat. All other areas of green space within the safeguarded area appear to comprise landscape planting of limited nature conservation value. An ecological walkover survey will be required to determine whether there is any protected or notable flora or fauna in the area, specifically those known to inhabit derelict urban and industrial areas, such as the Black Redstart.

The northern part of the Scheme is again dominated by industrial infrastructure of very limited nature conservation importance, although there are two small areas of semi-natural habitat within the area boundary. One comprises a triangle of scrubby woodland adjacent to the DLR (within the boundaries of the cement works) whilst the other (a larger triangle of land at the northern end of the application site, west of the A1020 roundabout, and also bounded to the west by the railway) appears to comprise a derelict post-industrial area of bare ground, ephemeral vegetation/grassland and scrub. Again, an ecological walkover survey will be required to determine the nature conservation value of the area.

Whilst none of these areas of habitat is identified on the Greenspace Information for Greater London (GIGL) plans, and they are likely to comprise relatively poor quality habitat, the potential nevertheless exists for habitats and species of at least local importance to be present. The safeguarded area will also need to be assessed for the presence of any invasive or injurious plant species.

Studies undertaken as part of Emirates Air Line Cable Car EIA show the River Thames and some of its tributaries are well established as providing an important nursery area for many juvenile fish. Fish surveys undertaken by the Environment Agency at Greenwich and Greenwich - Teddington recorded 19 species and 26 species, respectively from 2000 to 2010. These include the river lamprey *Lampetra fluviatilis* and sea lamprey *Petromyzon marinus*, European smelt *Osmerus eperlanus*, atlantic salmon *Salmo salar*, sea/brown trout *Salmo trutta*, European eel *Anguilla anguilla* and Twaite shad *Alosa fallax*.

## 3.5 Effects on all Travellers

### 3.5.1 Existing Public Rights of Way

Recreational routes include the Thames Path and National Cycle Route 1 that follow the riverside along the Greenwich Peninsula, as shown on Drawing 6.4-UA005651-UE31D and National Cycle Route 13 to the north of the River Thames. An extensive network of bicycle lanes and public footpaths is currently present in the area of the Scheme. Pedestrian and cycle connectivity is a fundamental element of London's multimodal transport system, enabling easy journeys to be made on foot or by bicycle using a permeable network of streets and footways. It is vital to consider the impact of the new crossing on pedestrian and cycle movement north and south of the river to minimise severance effects caused by the new road connection, and facilitate local movement between neighbourhoods and places.

### 3.5.2 Existing and Proposed Community Facilities. Severance.

The severance between residents on both sides of the river was partially alleviated with the Emirates Air Line Cable Car link which improved the connectivity between the north and south bank of the River Thames. A river bus service also runs from Queen Elizabeth II pier on the Peninsula to central London.

The Peninsula Masterplan envisages the development of a new entertainment/sports complex to the east of the Blackwall Tunnel Approach with a mixed development of high quality commercial and residential properties throughout the Greenwich Peninsula. The A102 corridor divides the peninsula but pedestrian and cycle connectivity is ensured through the provision of footbridge near Boord Street.

### 3.5.3 Amenity and Views from the Road

Views from the existing roads comprise the current mix of dense residential, commercial and industrial properties north of the River Thames and disused/derelict land and car parking facilities to the south of the River.

The streets shown on Drawing 6.4-UA005651-UE31D as 'key movement corridors and linear gateways' as defined in Newham's Core Strategy (London Borough of Newham, 2012) will be the subject of public realm and regenerative improvements that reinforce their role as high quality movement corridors and linear gateways.



### 3.5.4 Driver Stress

There is no baseline data presently available to undertake driver stress calculations although based upon the high levels of traffic flow and the existing levels of congestion, driver stress levels are expected to be high within the area particularly near Blackwall tunnel.

## 3.6 Geology and Soils

A Ground Investigation Desk Study (also known as a Preliminary Sources Study) was commissioned by TfL for the Scheme (Mott MacDonald, May 2013) and this has been used to inform the presentation of the baseline information outlined below.

### 3.6.1 Historic Land Use Information

The Greenwich Peninsula was previously dominated by the Southern Metropolitan gasworks which primarily produced town gas. The gasworks grew to 240 acres, the largest in Europe, and had its own extensive railway system connected to the main railway line near Charlton. Originally manufacturing gas from coal, the plant began to manufacture gas from oil in the 1960s.

During the 1980's and 1990's significant ground investigation was undertaken at the former gas works on the Greenwich Peninsula and this was followed by two stages of remediation: 'statutory' remediation undertaken by British Gas to remove the most significant contamination, and 'development' remediation undertaken by English Partnerships to render the site fit for its current use.

Statutory remediation comprised various methods including excavation and disposal, soil vapour extraction, soil washing, and groundwater treatment. The development remediation included additional removal of soils and installation of barrier systems to prevent migration of, and human contact with, contaminated ground. The areas under roads and car parks were capped by hard standing, and in park areas, a marker sheet was laid above contaminated soils, followed by capillary break, geotextile and 900 millimetres of clay.

### 3.6.2 Designated Sites

There are no geological SSSIs that could be affected by the Scheme. The nearest geological SSSI is Gilbert's Pit located over 2km to the east of the Scheme (refer to Drawing 6.1-UA005651-UE31D).

### 3.6.3 Geology and Hydrogeology

There is the presence of extensive Made Ground to the northeast and southeast of the Scheme. Superficial sediments exist around the docklands area comprising of alluvial deposits of the floodplain of the Thames which rests on the flood plain gravels (Thames River Terrace Deposits). These superficial sediments overlie solid geology which comprises London Clay, the Woolwich, Reading Beds and Upnor Formation of the Lambeth Group, Thanet Sand Formation and the White Chalk. In addition to the above, the presence of Made Ground is also indicated around the perimeter of the Royal Victoria Dock, the Tidal Basin and the former Royal Victoria Dock Western Entrance. Mostly, and originally, Made Ground was placed to raise the level of the land above the original level of the marshes which formed the area. Subsequently Made Ground is likely to be associated with the demolition and redevelopment of sites in the area.

The Scheme is situated within an area where the superficial deposits are classified as a 'Secondary Aquifer' however the Thanet Sand and White Chalk are classified as a 'Principal Aquifer'. The proposed options do not lie in close proximity to a source protection zone or source protection zone borehole.

The nearest surface water features are the River Thames and the Royal Victoria Dock. The River Lea joins the River Thames to the west of the northern approaches for the tunnel alignment. A small watercourse is identified on the north bank of the river near Scarab Close but further survey work will be required to determine the status of the watercourse.

### 3.6.4 Soils

The Scheme will be situated in an area with soils classified as having a high leaching potential according to the groundwater vulnerability map.

### 3.6.5 Contaminated Land

The potential for ground and groundwater contamination within the Scheme area has been addressed in the Phase 1 Contamination Assessment undertaken by Mott MacDonald as part of the Ground Investigation Desk Study commission. Overall the site has been given a moderate to high risk rating. The principal contamination sources comprise former land uses including rail land (including coal and goods depots), manure works, chemical works, garages and an engineering works as well as those associated with continued use for industrial activities. In addition, landfills have been identified in the area on both sides of the River Thames.

On the Greenwich Peninsula the principal contamination source relates to the former South Metropolitan Gasworks. A single remaining gas holder is the only above ground remnant of this former facility. The remaining gas holder appears to comprise a column guided installation. During a walkover survey undertaken by Mott MacDonald it was noted to be fully retracted (i.e. empty). The tank walls are surrounded by a low grassed bank. No access to the site was available.

The other holder was damaged by a bomb blast in 1978 and subsequently demolished. The decommissioned gas holder is located immediately to the north east and has been removed although the tank walls remain at least partially in the ground. It is understood that key sources of contamination, such as tar tanks and known contamination hot spots, were removed, groundwater remediation was undertaken and near surface soils were removed or cleaned prior to landscaping. However, it is understood that contaminated materials remain at depth beneath much of the site. Additionally, asbestos was encountered in the 'inert' backfill to the Western Entrance Lock to the Royal Victoria Dock during the ground investigation for the Emirates Air Line Cable Car project.

There are no sites determined as Contaminated Land under Part IIA of the Environmental Protection Act 1990 within 250m of the Scheme.

Contaminants associated with gas works include: volatile aromatics such as benzene, toluene, ethylbenzene and xylene (BTEX) compounds; phenolics (phenols and creosols); Polycyclic Aromatic Hydrocarbons (PAHs) which are present in coal tars and coal dust; hydrocarbons; and inorganic compounds such as heavy metals, cyanide, ammoniacal liquors and sulphate, and solid fuel residues including coal, coke, clinker and ash.

The northern side of the river has also historically been occupied by various industrial / commercial land uses which could be expected to have resulted in land contamination. There has been no widespread remediation undertaken in these locations and, as for Greenwich, it



can be expected that that further Phase 1 Surveys and Ground Investigations will be required to assess the risk and mitigation measures required for the Scheme.

## 3.7 Materials

A high level desk study has been undertaken to determine the baseline conditions associated with materials and waste. The tunnel engineering report commissioned by the Mott MacDonald (July 2013) was reviewed to identify the extent of excavation activities under each option. In addition, relevant planning documents have been reviewed, as they include some baseline data with regards to the volume of Construction Demolition and Excavation waste in the London Borough of Newham and the Royal Borough of Greenwich. All of this information has been used to inform the baseline description provided below.

According to The Mayor's Business Waste Strategy for London (November 2011), London produced an estimated 9.75 million tonnes of Construction Demolition and Excavation waste in 2010 of this total amount, 85% was recycled. Although this is a high percentage, it is still a considerable way from the target set in Policy 5.16 of exceeding 95% by 2020.

Using figures derived from the March 2010 'Future Waste Arisings in London 2010-2031' Summary Note Construction, Demolition and Excavation waste for the Royal Borough of Greenwich for 2013 was forecast to be 327,000 tonnes. For the London Borough of Newham 388,000 tonnes of Construction, Demolition and Excavation waste was forecast to be produced.

According to Environment Agency data published in 2010, the total non-hazardous and hazardous waste landfill capacity for London and the South-East was 40,876,000m<sup>3</sup> and 491,000 m<sup>3</sup> respectively. This provides the assessment baseline against which the potential impacts resulting from waste management and the use of resources associated with the works in the construction phases of each of the options.

The Centre for Environment, Fisheries and Aquaculture Science (CEFAS) encourages the beneficial use of dredged material rather than its disposal. In the Thames Estuary, the great majority of dredged material is either retained within the sedimentary system using water injection dredging, or taken to a beneficial use site at either Rainham (Essex) or Cliffe (Kent) which are managed by the RSPB for nature conservation. When applying for an application for a dredging licence contractors are required to consider the eventual location of dredged waste. The close proximity of the site to the River Thames and the local road network provides the opportunity to remove waste by either road or barge.

## 3.8 Noise and Vibration

Baseline noise maps produced by Defra and included in the Tunnel Engineering Study (Mott MacDonald June 2012) indicate that the existing baseline noise levels in the area are dominated by traffic related noise primarily from the A102 Blackwell Tunnel Approach on the Greenwich Peninsula and the A1020 Silvertown Way and Lower Lea Crossing on the northern side of the River Thames. In addition, noise from aircrafts using City Airport to the east, shipping on the River Thames, and DLR/Jubilee Line contributes to background noise levels in the area. Areas along the banks of the Thames and much of the Greenwich Peninsula have background noise levels of under 60 dB(A) while the aforementioned traffic routes have background noise levels in excess of 75 dB(A).

The area around the southern portal on the Greenwich Peninsula is currently undergoing significant redevelopment with the Greenwich Peninsula Masterplan indicating the construction of a number of residential and commercial properties in close proximity to the proposed options. There is the potential for new properties to be constructed in close proximity which may in turn

be impacted by the Scheme. There will need to be consideration of the location of worksites and hours of working and close consultation with neighbouring premises to reach satisfactory working arrangements.

Defra has produced Noise Action Plans which address the management of noise issues and effects from major roads, railway, aviation and industrial sources in England under the terms of the Environmental Noise (England) Regulations 2006. The Action Plans are intended to apply in particular to the most 'important areas' identified by the noise maps. Therefore, a set of Important Areas and First Priority Locations have been identified for each of the Noise Action Plans. There are First Priority Locations situated towards the north of the Scheme along the A13 and B125 and towards the south of the Scheme along the A102 and Trafalgar Road. There is also an Important Area situated on the A102 towards the south east of the Scheme.

## 3.9 Townscape and Visual

Desk-based review of the following planning documents informed the baseline description provided below:

- The London Plan (2011)
- Newham Core Strategy (2012)
- Greenwich Unitary Development Plan (2006)

Baseline townscape and visual features are shown on Drawing 5.5-UA005651-UE31D.

The Scheme lies within the Thames Policy Area which aims to promote high quality of design respecting the special character of the River Thames. The London Plan requires Thames-side boroughs to identify these policy areas and formulate corresponding policy that is consistent with the London Plan. As a result, the Scheme will need to be considered in the context of Greenwich Unitary Development Plan (UDP) Policy W2 (Thames Policy Area) and Newham Core Strategy Policy INF7 (Blue Ribbon Network) which set out local planning policy for protection and enhancement of townscape and views within respective Thames Policy Areas. In addition, the Local Views identified in Greenwich UDP Policy D27, together with views from sensitive visual receptors such as national recreational trails/routes/facilities, including the Thames Path (south of the River Thames), National Cycle Route 1 (south of the River Thames), National Cycle Route 13 (north of the River Thames) and Emirates Air Line Cable Car, are taken into account in the assessment. There are no Conservation Areas within the study area.

Large scale developments are present including Canary Wharf to the west on the Isle of Dogs, the Blackwall Reach developments, the O2 and associated high rise office developments on the Greenwich Peninsula, and the recent developments surrounding the Royal Victoria Dock.

Areas of public open space are limited to Central Park on the Greenwich Peninsula. Infrastructure elements are prominent notably the A102 Road Blackwell Tunnel Approach, Silvertown Way and the DLR. The River Thames in this section supports working wharves and commercial riverside activities. River transport accommodates both commercial and passenger traffic. Greenwich yacht club has riverside mooring along Bugsby's Reach.

Recreational routes include the Thames path and National Cycle Route 1 following the riverside along the Greenwich Peninsula.

Overall, the study area is not tranquil. Major road and rail infrastructure crosses the area together with the presence of London City Airport. The public open spaces are affected either by the airport flight path (the Royal Docks) or elevated road and rail infrastructure (the Royal

Docks and Lea Park/East India Dock basin). Central Park is relatively quiet partly due to the vacant development plots adjacent and low traffic levels during the day.

## 3.10 Water Environment

### 3.10.1 Surface Water Quality

There are two main rivers located within the immediate vicinity of the safeguarded area, the River Thames and the River Lea.

The River Thames flows in a southeast ward direction and discharges into the sea approximately 42 kilometres downstream. The Thames is tidal at the Scheme site with a normal tidal height of up to 3.56 metres above ordnance datum (Mean High Water Spring). However, water levels can be significantly higher such as observed on 1 February 1953 when levels in the Thames reached 5.26 metres above ordnance datum following a storm surge in the North Sea.

The Thames has been classified as of 'moderate' ecological status under the Thames River Basin Management Plan - Estuarine. Its chemical status has been recorded as 'fail', which means that it does not comply with the environmental chemical standards in the Environmental Quality Standards Directive. As the river is tidal at this location, there is a high degree of water mixing and high suspended solids. The highest suspended solids value recorded 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 (Environment Agency data).

The River Lea flows southwards before it joins the Thames and is located to the west of the Silvertown portal area of the Scheme. The lower reaches of the river are managed under the Thames River Basin Management Plan - Estuarine and have been classified as having 'moderate' ecological status, while the chemical status is classed as 'fail'.

### 3.10.2 Groundwater Quality

The Scheme is not located within, or in close proximity to, a groundwater Source Protection Zone (SPZ). The River Terrace Gravels below the safeguarded area have been classified as a secondary (undifferentiated) aquifer, due to their high permeability but limited extent. The secondary B groundwater within the aquifers underlying the London Clay Formation has been classified as having 'poor' quantitative quality and 'poor' (deteriorating) chemical quality.

The River Terrace Gravels are likely to be hydraulically isolated from the underlying secondary aquifers; the Lambeth Group and Thanet Sand Formation and the principal aquifer, the Chalk Formation by the London Clay. However, as the London Clay is of variable thickness and absent in the southern part of the Greenwich Peninsula, it is possible that there is some degree of connectivity between the alluvial deposits and the underlying aquifer.

There are two groundwater abstractions on the Greenwich side of the Scheme. These abstractions are located approximately 100m north of the portal.

### 3.10.3 Existing Flood Risk and Drainage

At both the northern and southern portals, the Scheme crosses the defended floodplain of the tidal River Thames. Areas of land within the application boundary are located within both Flood Zone 3 (High Risk) and Flood Zone 2 (Medium Risk). However, when the effect of existing flood defences is accounted for, the likelihood of flooding has been assessed by the EA as low. The main source of flood risk to the Scheme is therefore from breach of existing flood defences. Hydraulic modelling of breach scenarios, undertaken to inform the Newham Strategic Flood

Risk Assessment (SFRA) and the Greenwich SFRA, predicted floodwater depths of 3.1m and 2.6m at the proposed northern and southern tunnel approaches respectively during the 1 in 200 year plus climate change breach event.

The Greenwich Peninsula has been identified as being in a flood risk area but is currently protected by river walls. The London Regional Flood Risk Assessment (2009) identifies that these walls may need to be raised beyond 2030. Both the Silvertown Tunnel and the Blackwall Tunnel will have a particular risk as their portals and ventilation shafts are within the tidal Thames flood risk zone. In addition to the flood risk from the tidal Thames, the permeability of the flood plain alluvial layers makes groundwater infiltration a possible risk.

## 4 Options Comparison

In general terms for the majority of topics the environmental risks will be similar for all tunnel options as the location, horizontal alignment, and capacity of the options suggest similar baseline conditions, same receptors and same levels of traffic flows during operation. At present uncertainty exists with regards to the exact location of the casting basin with options A and A+B; therefore the identification of environmental risks for these two options is not considered within this Options Study Report.

Table 4-1 provides details of the environmental risks and proposed mitigation measures for each environmental topic in a comparative manner for the bored 'Base' option and immersed tube 'Base' option.

Table 4-2 presents a comparison between the environmental risks identified with the 'Base' options and those likely to occur with the 'Shortened' options (B & C).

**Table 4-1 Options Comparison (Bored and Immersed Tube 'Base' options)**

Environmental topic	Bored 'Base' option		Immersed Tube 'Base' option		Options Comparison Comments
	Environmental Risks	Mitigation Measures	Environmental Risks	Mitigation Measures	
<b>Air Quality</b>	<p>Receptors likely to be affected include commercial and residential developments located on the Greenwich Peninsula and at the western boundary of the Royal Victoria Dock.</p> <p>During the construction of the scheme works will include the removal and storage of excavated materials which has the potential lead to the generation of dust. In addition dust can be liberated through the movement of material by vehicles and site plant.</p> <p>During operation of the Scheme a new road layout will be required at Greenwich Peninsula and Silvertown to allow access to the new Silvertown tunnel crossing. Given that this is likely to result in increases in road traffic there is the potential for deterioration in local air quality within the AQMAs designated by the London Borough of Newham and Greenwich. There are likely to be both improvements in air quality and deterioration in air quality at receptors as a result of the change in traffic flows.</p>	<p>Construction dust can be mitigated in accordance with best practice with the measures documented in a Construction Environmental Management Plan (CEMP).</p> <p>There are limited mitigation measures to control emissions from vehicles as a result of the Scheme; however the attractiveness of the Scheme could be influenced by tolling charges.</p> <p>Ventilation of the tunnel can be designed in order to mitigate any significant impacts on receptors (for example increased stack height would aid dispersion).</p>	<p>During the construction of the scheme works will include the removal and storage of excavated materials which has the potential to lead to the generation of dust. In addition dust can be liberated through the movement of material by vehicles.</p> <p>Removal by barge is an option which could reduce potential vehicle movements and avoid raising the air quality and noise issue.</p> <p>Environmental risks and associated mitigation measures are considered to be the similar to the bored 'Base' option as air quality will be affected by the same level of traffic flow with both options.</p>	<p>Same as bored 'Base' option.</p>	<p>The environmental risks will be the same for bored 'Base' option and immersed tube 'Base' option due to similar design and capacity of both tunnel options hence same level of traffic flows during construction and operation.</p> <p>The same number of receptors will be affected with each option.</p>
<b>Community</b>	At present the land uses in the	No mitigation measures	The immersed tunnel option, when	No mitigation measures	Given that the land uses in

Environmental topic	Bored 'Base' option		Immersed Tube 'Base' option		Options Comparison Comments
	Environmental Risks	Mitigation Measures	Environmental Risks	Mitigation Measures	
<b>and Private Assets</b>	immediate vicinity of the proposed options mainly comprise derelict land and industrial premises. Permanent land take related to the option will be minimal and confined to small areas of currently safeguarded land on both sides of the Thames. Environmental risks associated with land take and subsequently land use are not anticipated to be significant.	required.	compared with the bored tunnel, requires a greater area of land to be constructed (work sites, casting basin, etc.). Although the environmental risks associated with land take are anticipated to be greater than the bored tunnel, they will be temporary.	required.	the vicinity of the proposed options do not suggest the demolition of any residential properties or important community facilities it is considered that once operational the overall environmental risks will be the similar for both 'Base' options.
<b>Cultural Heritage</b>	<p>The proposed bored tunnelling works are anticipated to be at sufficient depths to avoid impacting on archaeological remains however the tunnel portals are likely to result in the removal of any archaeological remains situated within the portal footprints.</p> <p>The archaeological potential at this stage is unknown; therefore further archaeological assessment work may be required at a later stage to confirm impacts.</p>	Consultation with English Heritage and further archaeological work will be required to assess the potential impacts the option will have on archaeological resources prior to the commencement of construction. Mitigation measures such as archaeological watching briefs to be undertaken during the construction of the scheme.	Given that the immersed tunnel option, when compared with the bored tunnel, requires a greater area of land to be constructed, there is greater potential to disturb archaeological remains within the areas of archaeological potential as designated by the London Boroughs of Greenwich and Newham. The immersed tunnel will also require a channel to be dredged in the River Thames. This is likely to remove any archaeological resources located within the Archaeological Priority Area designated by the London Borough of Newham which extends to the centre of the River Thames.	Consultation with English Heritage and further archaeological work will be required to assess the potential impacts the option will have on archaeological resources prior to the commencement of construction. Mitigation measures such as archaeological watching briefs to be undertaken during the construction of the scheme.	Given that the construction methodology of the immersed tube tunnel is likely to affect more heritage assets (including in the River Thames) it is considered that the environmental risks associated with the Immersed Tube 'Base' option are higher.
<b>Ecology and Nature Conservation</b>	<b>Terrestrial Ecology</b> Whilst the tunnel portals will be constructed in areas of land that are largely urban and are not particularly	<b>Terrestrial Ecology</b> Retain as much as possible of the scrub/woodland habitat	<b>Terrestrial Ecology</b> The environmental risks will be similar to the bored 'Base' option, although there may be additional	<b>Terrestrial Ecology</b> There would be a greater temporary loss of habitat on the foreshores and	Higher environmental risks are likely with the immersed tube 'Base' option due to dredging operations during



Environmental topic	Bored 'Base' option		Immersed Tube 'Base' option		Options Comparison Comments
	Environmental Risks	Mitigation Measures	Environmental Risks	Mitigation Measures	
	<p>regarded as ecologically sensitive, the loss of the areas of scrub/ grassland and woodland habitat could be significant in a borough context given the shortage of such habitat locally.</p> <p>The area required for the construction of the southern end of the Scheme includes an area of derelict land that appears to be heavily overgrown with a mixture of small trees and scrub. This is one of the only patches of such habitat on the Greenwich Peninsula, and has been identified on Natural England's website as 'deciduous woodland', a BAP habitat. All other areas of green space within this option appear to comprise landscape planting of limited nature conservation value.</p> <p><b>Marine Ecology</b></p> <p>The bored 'Base' option will involve tunnelling beneath the River Thames which is designated as the River Thames &amp; Tidal Tributaries SINC. Given that the River Thames will not be directly affected by the tunnelling, the Scheme is likely only to result in indirect effects on ecology within the River Thames from, for example, elevated noise levels or the risk of accidental spillages during construction.</p>	<p>within the Scheme.</p> <p>In the case that the scrub/woodland habitat cannot be retained, consideration should be given to incorporating similar habitat types within the design of the completed Scheme.</p> <p><b>Marine Ecology</b></p> <p>Pollution control measures.</p>	<p>risks associated with the casting basin, the location of which is unknown.</p> <p><b>Marine Ecology</b></p> <p>The construction of an immersed tube tunnel will have an impact on the River Thames and Tidal Tributaries SINC which supports some habitats of conservation importance (e.g. intertidal mudflats) and ecological important biota (e.g. birds and fish). The potential environmental risks of this will include:</p> <ul style="list-style-type: none"> <li>▪ Temporary loss of intertidal mudflat habitat and associated benthos from the construction of the immersed tunnel</li> <li>▪ Temporary disturbance to intertidal mudflat and associated benthos resulting in temporary disturbance to bird communities caused through installation of the cofferdams</li> <li>▪ Temporary reduction in water quality as a result of an increase in suspended solids and release of contaminant bound sediments causing temporary effects in fish and other biota during the dredging operations</li> <li>▪ Temporary increase in aquatic</li> </ul>	<p>compensation measures (e.g. creation of habitat) may be required.</p> <p><b>Marine Ecology</b></p> <p>Measures will need to be incorporated into the CEMP to ensure that there would be no significant impacts on aquatic habitats associated with sedimentation or pollution.</p> <p>The mitigation measures associated with potential risks associated with dredging are:</p> <ul style="list-style-type: none"> <li>▪ Spill control and hence controlling turbidity during agitation dredging of alluvium, bulk dredging and maintenance dredging</li> <li>▪ Dredging during winter season to avoid fish migrations</li> <li>▪ Licensed disposal of contaminated materials and non-</li> </ul>	<p>construction and the vertical alignment of the immersed tube tunnel. The immersed tube 'Base' option will also require more additional survey work and consultation with non-statutory consultees to confirm the presence of protected species and identify appropriate mitigation. More complex mitigation measures are likely to be required as more habitats are likely to be affected by the immersed tube tunnel.</p> <p>The effect on the river dynamics due to the foreshore cofferdams and the dredged trench will require numerical modelling to accurately predict the effect on current flows and determine the extent of erosion and deposition within the river.</p>



Environmental topic	Bored 'Base' option		Immersed Tube 'Base' option		Options Comparison Comments
	Environmental Risks	Mitigation Measures	Environmental Risks	Mitigation Measures	
			<p>noise levels during the installation of the immersed tunnel which could have adverse effects on marine mammals and fish.</p> <p>The construction of an immersed tunnel has the potential to significantly affect marine ecology from dredging operations. Dredging may prevent adult fish from migrating upstream to possible spawning grounds and result in mortality in younger fish. In addition, mobilisation of contaminated sediments has the potential to cause some direct toxicological effects leading to impairment of physiological functions in fish. Combined effects of dredging, outfalls and development are likely to occur during the summer months of June to August when dissolved oxygen levels are at their lowest.</p> <p>The need to undertake construction works and dredging within the river to construct an immersed tunnel could result in the deterioration of water quality, elevated suspended sediments in the river and the loss of intertidal mudflats during construction and during operation if permanent structures are needed in the river.</p>	<p>contaminated materials.</p> <p>Dredging work will need to be licensed and comply with criteria for turbidity and oxygen levels.</p>	
<b>Effects on All</b>	The key receptors will be non-motorised users such as pedestrians	Mitigation measures	The environmental risks associated with the immersed tube 'Base' option	In addition to the mitigation measures	On the whole the environmental risks of the

Environmental topic	Bored 'Base' option		Immersed Tube 'Base' option		Options Comparison Comments
	Environmental Risks	Mitigation Measures	Environmental Risks	Mitigation Measures	
<b>Travellers</b>	<p>and cyclists and vehicle drivers for the view from the road and driver stress assessments. The construction of the bored tunnel is likely to result in the followings environmental risks:</p> <ul style="list-style-type: none"> <li>▪ Reduced amenity for the users of the cycle routes and footpaths in the vicinity of the tunnel portal</li> <li>▪ Changes in the pedestrian crossings that currently exist on both sides of the river</li> <li>▪ Increased severance on certain roads depending upon the traffic changes</li> <li>▪ Reduced drivers stress as a result of reduced congestion and enhanced road layout</li> <li>▪ Improvements to public transport connections</li> </ul>	<p>include:</p> <ul style="list-style-type: none"> <li>▪ The construction of a new footbridge near Boord Street</li> <li>▪ Ensuring the Scheme design makes appropriate provision for pedestrian crossings when designing the new highway arrangements at each of the tunnel portals</li> <li>▪ Minimising footpath and cycle route diversions both during construction and also those that may be needed permanently during Scheme operation</li> <li>▪ Ensuring clear signage for non-motorised users</li> <li>▪ Ensuring the design of the Scheme reflects public transport needs.</li> </ul>	<p>are similar to those identified with the bored 'Base' option.</p> <p>The key receptors will additionally include the river users.</p> <p>Navigation issues are anticipated on the River Thames during construction works. The immersion of tunnel elements will require short term closure of the river.</p> <p>Depending on the exact location of the cofferdam basin, cycle and pedestrian routes on the both sides of the river are likely to be affected.</p>	<p>proposed for the bored 'Base' option, the immersion of the tunnel elements will require the advanced coordination with Port of London Authority (PLA) to reduce the environmental risks associated with the temporary closure of the river and disruption of river traffic.</p>	<p>two tunnel options are considered to be similar. More receptors are likely to be affected during construction of the immersed tube tunnel hence additional mitigation measures may need to be implemented to reduce the environmental risks with regards to navigation.</p>
<b>Geology and Soils</b>	<p>Environmental risks associated with the bored 'Base' option include:</p> <ul style="list-style-type: none"> <li>▪ Disturbance of potentially contaminated land and areas of</li> </ul>	<p>Potential mitigation measures will include:</p> <ul style="list-style-type: none"> <li>▪ Treatment of contaminated land based</li> </ul>	<p>The immersed tube tunnel will be relatively shallow and may therefore pose a higher risk of disturbing the underlying contaminated soils. This</p>	<p>Same as for bored 'Base' option.</p>	<p>Although the environmental risks and associated mitigation measure are considered to be essentially</p>

Environmental topic	Bored 'Base' option		Immersed Tube 'Base' option		Options Comparison Comments
	Environmental Risks	Mitigation Measures	Environmental Risks	Mitigation Measures	
	<p>Made Ground</p> <ul style="list-style-type: none"> <li>Mobilising contaminants in the soil that would otherwise be immobile</li> <li>Creation of new pollutant pathways for contamination to reach groundwater and surface water resources</li> <li>Creation of contaminated run-off that could affect surface and groundwater resources</li> <li>Effects of the tunnel construction on ground stability</li> </ul> <p>The cut and cover sections are generally deeper for the bored tunnel option than for the immersed tube option therefore the excavated material from the deeper ground is less likely to be contaminated (apart from the ground break point to place the TBM at Silvertown end).</p>	<p>on the information obtained from the site investigation</p> <ul style="list-style-type: none"> <li>Completion of Risk Assessments and a Remediation Strategy (if required) and adherence to them throughout the construction works</li> <li>Adherence to the Construction Code of Practice for the Sustainable Use of Soils on Construction Sites (Defra, 2009)</li> <li>Adherence to Environment Agency Pollution Prevention Guidelines</li> <li>Use of a CEMP.</li> </ul>	<p>could result in the contamination of controlled waters such as groundwater within the Secondary aquifer and the River Thames. Contamination could migrate horizontally and vertically along newly created preferential pathways such as drainage runs, piles and site investigation boreholes.</p> <p>The casting basin requirements of this option will result in a greater amount of excavation work near the River Thames hence higher risk to create pollutant pathways.</p>		<p>the same for both options, it is anticipated that the excavation and disposal of the shallow (potentially contaminated) soil layers in close proximity to the river Thames with the immersed tube 'Base' option will pose more risk of mobilising contaminants and creating new pathways.</p>
<b>Materials</b>	<p>The following environmental risks are identified:</p> <ul style="list-style-type: none"> <li>Waste generated as a result of excavation works</li> <li>Increased pressure on waste management and disposal facilities</li> <li>Energy consumption through plant use and transportation of materials and waste</li> </ul>	<ul style="list-style-type: none"> <li>Optimise the design of the Scheme to reduce need for materials import and minimise waste (including proactive engagement with the design team to encourage the selection of materials taking account of their potential environmental</li> </ul>	<p>The immersed tube tunnel will generate around 40% more waste materials due to earthworks excavations of the casting basin and excavation of the open cut and cover passages at the entrance and exits from the tunnel. Waste material will also arise from the dredged channel in which the immersed tunnel will be constructed within the River Thames. For an immersed tunnel there are</p>	<p>Where re-use is not possible there will be a requirement to dispose of excavated material by licensed carriers to licensed landfill sites and handled in accordance with the Waste Management Regulations.</p>	<p>The immersed tube tunnel generates approximately 40% more waste material. The earthworks excavations on land for the immersed tube 'Base' option include lengthy cut and cover tunnels at each approach and the casting basin on-site will yield significant quantities of River Terrace</p>

Environmental topic	Bored 'Base' option		Immersed Tube 'Base' option		Options Comparison Comments
	Environmental Risks	Mitigation Measures	Environmental Risks	Mitigation Measures	
	<ul style="list-style-type: none"> <li>Release of contaminants to air, land or water through the sourcing, use, storage, transportation and disposal of materials and waste that could result in pollution</li> <li>Flooding as a result of inappropriate materials and/or waste storage</li> </ul> <p>The excavated material from tunnelling activity will predominately be removed from the site at which the TBM enters the ground and from the area of the cut and cover and open cut portals located and the northern and southern ends of the tunnel at Silvertown and the Greenwich Peninsula respectively. The spoil disposal quantities for the bored 'Base' option are 520,000 m<sup>3</sup></p>	<ul style="list-style-type: none"> <li>effects) <ul style="list-style-type: none"> <li>A CEMP documenting control measures for the use, storage and transportation of materials as well as the storage and transportation of wastes</li> <li>A Site Waste Management Plan that will outline the types and quantities of wastes that would be generated and how they would be reduced, re-used, managed and disposed of</li> <li>Examine the potential re-use and disposal options for excavated material and in particular re-use options for London Clay.</li> </ul> </li> </ul>	<p>large volumes of material arising and large volumes required for backfilling. The spoil disposal quantity is significantly higher when compared to the bored tunnel option (1,200,000 m<sup>3</sup>). The dredged cohesive material will not be suitable for re-use as backfill to the tunnel elements and will need to be disposed of. Terrace gravels may be re-usable but the volumes are small and the cost of storage on site and re-handling to place the material as backfill may be prohibitive. It is therefore unlikely these materials will be re-used.</p>		<p>deposits and London Clay. Limited mitigation options are available much of the waste material may not be suitable to re-use.</p>
<b>Noise and Vibration</b>	<p>The construction and operation of new tunnel crossing has the potential to cause increase in traffic noise on an existing road by altering the traffic flow and composition. In the case of the bored tunnel a completely new noise</p>	<ul style="list-style-type: none"> <li>Thin/low-noise surfacing can reduce noise levels by up to 3.5dB (A) where the average speed of the traffic is above 75 mph.</li> </ul>	<p>Same as bored 'Base' option.</p>	<p>Same as bored 'Base' option.</p>	<p>The environmental risks and mitigation measures associated with noise will be the same for both options due to the same number and location of receptors</p>

Environmental topic	Bored 'Base' option		Immersed Tube 'Base' option		Options Comparison Comments
	Environmental Risks	Mitigation Measures	Environmental Risks	Mitigation Measures	
	<p>source would be created which could have a significant effect upon the existing noise climate.</p> <p>The majority of residential receptors within the anticipated noise study area are located on the northern side of the Scheme in Canning Town. Road traffic noise on the southern side from the A102 and on the northern side from the A1011 and A13 would be the most likely sources of road traffic noise.</p>	<p>Below this speed there is a reduced benefit from a thin/low-noise surface due to vehicle engine noise contributing more to the overall noise level</p> <ul style="list-style-type: none"> <li>▪ The use of noise barriers can reduce the noise level at dwellings by reducing sound propagation. To be most effective, barriers are required to be either very close to the source (the road) or the receptor (the dwellings)</li> <li>▪ A reduction in the average speed of vehicles can result in a reduction in traffic noise</li> <li>▪ Noise insulation for residents.</li> </ul>			and same levels of traffic flow.
<b>Townscape and Visual</b>	<p>Given the surrounding townscape and that the majority of the crossing infrastructure would be below the ground, it is not anticipated any significant impacts to occur outside the areas of the portals.</p>	<ul style="list-style-type: none"> <li>▪ Achieving finishes to engineering structures that are appropriate to townscape context and visual amenity</li> <li>▪ Appropriate landscaping</li> </ul>	<p>This option has a potential for greater visual impact during construction due to larger construction area located on-site. Receptors include users of the Emirates Air Line Cable Car and residents on both sides of the river.</p>	<ul style="list-style-type: none"> <li>▪ Location of the casting basin off-site.</li> </ul>	<p>The construction of the immersed tube tunnel is likely to result in significant temporary deterioration of the existing views. There will be no significant difference between the 'Base' options</p>

Environmental topic	Bored 'Base' option		Immersed Tube 'Base' option		Options Comparison Comments
	Environmental Risks	Mitigation Measures	Environmental Risks	Mitigation Measures	
		<ul style="list-style-type: none"> <li>Ensuring an appropriate lighting design.</li> </ul>			once the tunnel is operational.
<b>Water Environment</b>	<p>Given the nature of the works it less likely that the bored tunnel option will directly affect any surface watercourses as no works are proposed within the River Thames or the River Lea. The realignment of Dock Road on the north bank of the river is likely to affect a small surface watercourse in the vicinity of Scarab Close and mitigation measures may be required, e.g. covering or diverting the water.</p> <p>Potential environmental risks include increased flood risk as a result of works in close proximity to, or the crossing of, existing flood defences, the introduction of impermeable surfaces and loss of floodplain storage where the linking highway network is constructed. In addition, there is also potential for detriment to the water quality of groundwater waterbodies associated with heavily silted, or otherwise contaminated, runoff from construction sites. Existing river walls are primarily formed from steel sheet piling and there is a risk of encountering these during bored tunnelling works.</p>	<p>Where works are undertaken in close proximity to the flood defences along the banks of either the River Thames or the River Lea consent from the Environment Agency for works affecting watercourses and/or flood defences will be required prior to undertaking the works.</p> <p>Given the nature of the work, location and the size of the site it is anticipated that a formal flood risk assessment will be undertaken and approved by the Environment Agency.</p>	<p>Construction of the immersed tunnel will require the localised demolition of the river flood defence walls to allow the connection with the landside structures. Temporary cofferdams will need to be constructed to maintain flood defences during the works. In addition, there is also potential for detriment to the water quality of groundwater and surface waterbodies associated with heavily silted, or otherwise contaminated, runoff from construction sites.</p> <p>Given the need for dredging and the construction methods of the immersed tunnel within the River Thames, it is anticipated that environmental risks are likely to occur with regards to changes to water level, flow paths and dynamics and the movement of sediment within the River.</p> <p>The realignment of Dock Road on the north bank of the river is likely to affect a small surface watercourse in the vicinity of Scarab Close and mitigation measures may be required, e.g. covering or diverting the water.</p>	<p>In addition to the mitigation measures proposed for the bored tunnel option and based on the experience on the Emirates Air Line Cable Car project, it is anticipated that a scouring assessment will also be required to assess the impact of the Scheme on water flow and sediment transport, particularly around Bugsby's Reach which, according to the EA, is susceptible to severe erosion (Mott MacDonald, 2012).</p> <p>Mitigation measures to minimise the impacts on water quality from sediment suspension:</p> <ul style="list-style-type: none"> <li>Enclosed grab dredger used to minimise sediment suspension during of alluvial silt and clay in</li> </ul>	<p>When compared with the bored 'Base' option, the proposed immersed tunnel option has the potential to result in significant adverse effects that require mitigation measures and the approval of both the Environment Agency and the Port of London Authority (PLA) prior to commencing works. The hydrodynamic modelling is important because it will indicate whether any additional inter-tidal habitat loss is expected as a result of erosion. The results of the modelling should also confirm that erosion will not adversely affect the integrity of the flood defences if the bed level is reduced due to scouring. Where bed levels are lowered this can reduce the stability of the tidal defence retaining walls.</p>

Environmental topic	Bored 'Base' option		Immersed Tube 'Base' option		Options Comparison Comments
	Environmental Risks	Mitigation Measures	Environmental Risks	Mitigation Measures	
				<p>the river channel</p> <ul style="list-style-type: none"> <li>▪ Sediment suspension reduced by the backfilling method (fall pipe used to control placement of fill material)</li> <li>▪ Clean sand and gravel used for backfilling</li> <li>▪ Reducing sediment suspension from control structures, e.g. silt curtains and bubble curtains</li> <li>▪ Dredging restricted between November and March, avoiding indirect water quality impact on fish migration</li> <li>▪ Construction works monitoring at 15 minute intervals during dredging including turbidity, salinity and temperature.</li> </ul>	

**Table 4-2 Options Comparison ('Base' options vs 'Shortened' (B and C) options)**

Environmental topic	'Base' options		B and C options		Options Comparison Comments
	Environmental risks	Mitigation measures	Environmental risks	Mitigation measures	
<b>Air Quality</b>	The options have the potential to result in increase of traffic flows and hence change emissions on the local road network. There are likely to be both improvements in air quality and deterioration in air quality at receptors as a result of the change in traffic flows.	The mitigation measures will be the same as those listed in Table 4.1.	The environmental risks are considered to be similar as the 'Base' options as air quality will be affected by the same levels of traffic flow with all of the proposed options.  As the location of the tunnel portals will be moved closer to the River the concentration of exhaust fumes in the areas immediately adjacent to the tunnel portals is likely to affect users of the commercial buildings located nearby.	The mitigation measures will be the same as those listed in Table 4.1.	There is no significant difference between the two sets of options. The location of sensitive receptors with the 'shortened' options will be closer to the river Thames but it is not considered that this will affect more receptors than those affected if the any of the 'Base' Options is taken forward.

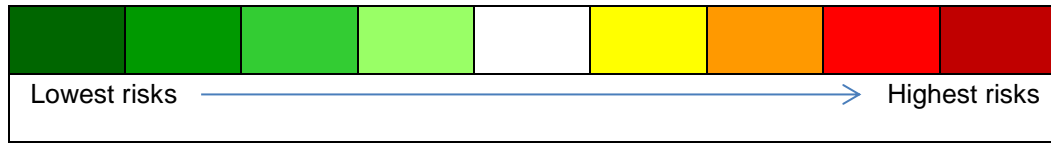


<b>Community and Private Assets</b>	Permanent land take related to the options will be confined to areas of currently safeguarded land on both sides of the Thames. Impacts on land take and subsequently land use are anticipated to be with regards to worksites and casting basin (for immersed tube option) and temporary land-take for the cut and cover sections on both sides of the River with both 'Base' options.	No mitigation measures required.	More land take will be required with the 'Shortened' options as the exit road on the south side of the River runs above ground rather than in a cut-and-cover tunnel. Loss of potentially developable land on both sides of Edmund Halley Way may have an impact on Greenwich Peninsula Masterplan proposals reducing the land allocated for residential/business use.  In addition, environmental risks associated with noise pollution are likely to occur in the open road section on the south side of the River affecting receptors in the residential development immediately adjacent to Millennium Way road.	No mitigation measures required.	More receptors are likely to be affected by the open road section on the south side of the river. Although it is unlikely that any compensation measures will be required with regards to land take at this design stage of the Scheme, consideration should be given to the fact that more permanent land take will be required with the 'Shortened' options.
<b>Cultural Heritage</b>	The environmental risks and associated mitigation measures of options B and C ('Shortened') are unlikely to be significantly different from those of the 'Base' options described in Table 4.1.				No significant difference.
<b>Ecology and Nature Conservation</b>	The environmental risks and associated mitigation measures of options B and C ('Shortened') are unlikely to be significantly different from those of the 'Base' options described in Table 4.1.				No significant difference.

<b>Effects on All Travellers</b>	<p>The construction of the long tunnel options is likely to result in the following environmental risks:</p> <ul style="list-style-type: none"> <li>▪ Changes in the multiple pedestrian crossings that currently exist on both sides of the river</li> <li>▪ Increased severance on certain roads depending upon the traffic changes.</li> <li>▪ Reduced drivers stress as a result of reduced congestion and enhanced road layout</li> <li>▪ Reduced amenity for the users of the cycle routes and footpaths in the vicinity of the tunnel portal.</li> </ul>	<p>The mitigation measures will be the same as those listed in Table 4.1.</p>	<p>In addition to the environmental risks identified with the 'Base' options, increased severance is likely to occur in the northern part of the Greenwich Peninsula for west-east movements.</p> <p>Options B and C will allow more open views from the road as the cut and cover section on the south side of the river will be reduced.</p>	<p>Severance of east-west movements on the south side of the river will be slightly alleviated with a new pedestrian bridge in the area of Edmund Halley Way (see Drawing MMD-298348-C-DR-00-ZZ-1060_P1).</p>	<p>Although the construction of new pedestrian bridge at Edmund Halley Way will alleviate the severance issues on the south side of the River, the overall severance in the area will be worse as the open cut road will be a barrier to movement for non-motorised users in the northern part of the peninsula.</p>
<b>Geology and Soils</b>	<p>The environmental risks and associated mitigation measures of options B and C ('Shortened') are unlikely to be significantly different from those of the 'Base' options described in Table 4.1.</p>			<p>No significant difference.</p>	
<b>Materials</b>	<p>The environmental risks and associated mitigation measures of options B and C ('Shortened') are unlikely to be significantly different from those of the 'Base' options described in Table 4.1.</p>			<p>No significant difference.</p>	

<p><b>Noise and Vibration</b></p>	<p>The 'Base' options have the potential to cause an increase in traffic noise on an existing road by altering the traffic flow and composition.</p>	<p>Measures to minimise environmental risks will be required (e.g. thin/low-noise surfacing, noise barriers, reduction in the average speed of vehicles, etc.)</p>	<p>Environmental risks will be associated with increased traffic noise from the open road on the approach to the tunnel in the south section of the Scheme. The Greenwich Peninsula Masterplan envisages residential development northeast of Millennium Way Road which currently is anticipated to comprise of 18 residential buildings (Class 2 and/or 3). In addition, key sensitive receptors likely to be affected by the increased traffic noise levels are identified 0.5 miles south of the proposed tunnel approach road at Millennium Primary School (see Drawing 6-2 – UA005651- UE31D)</p>	<p>Measures to minimise environmental risks will be required (e.g. thin/low-noise surfacing, noise barriers, reduction in the average speed of vehicles, etc.)</p>	<p>More receptors are likely to be affected with the 'Shortened' B and C options including some key sensitive receptors located to the east of the Scheme. Mitigation measures will be essentially the same, but noise barriers will be located in slightly different areas (closer to the key sensitive receptors).</p>
<p><b>Townscape and Visual</b></p>	<p>The construction of the immersed tube tunnel is likely to result in significant temporary deterioration of the existing views. There will be no significant visual impact once the tunnel is operational.</p>	<p>Potential mitigation measures during construction of the immersed tube tunnel will be locating the casting basin off-site.</p>	<p>The raised level of the open road on the south side of the River Thames has the potential to permanently deteriorate the existing views affecting a number of receptors. The cut and cover section will be reduced and the approach road to the tunnel as well as associated infrastructure will be visible to users of the Emirates Air Line Cable Car, visitors of the commercial buildings and leisure facilities and residents on both sides of the new road.</p>	<p>Potential mitigation measures include:</p> <ul style="list-style-type: none"> <li>▪ Achieving finishes to engineering structures that are appropriate to townscape context and visual amenity</li> <li>▪ Appropriate landscaping</li> </ul>	<p>The 'Shortened' options B and C are likely to negatively affect a wider variety of receptors particularly on the south side of the River Thames. More complex mitigation measures will be required to address some permanent visual impacts related to the 'Shortened' tunnel options.</p>
<p><b>Water Environment</b></p>	<p>The environmental risks and associated mitigation measures of options B and C ('Shortened') are unlikely to be significantly different from those of the 'Base' options described in Table 4.1. Flood/drainage issues associated with reducing the level of Millennium Way Road with the 'Shortened' and C options are anticipated, but these can be mitigated through careful design.</p>				<p>On the whole there is no significant difference between the two sets of tunnel options.</p>

The scale below was used to compare the environmental risks and level of deliverability of each of the four options and the findings are presented in Table 4-3. It is considered that the higher the environmental risks are, the level of deliverability of the option will be lower.



**Table 4-3 Environmental Risks and Deliverability of Options**

Environmental Topic	Bored 'Base' option	Shortened (C) Option	Immersed Tube 'Base' option	Shortened (B) Option
Air Quality	Orange, Light Green	Orange, Light Green	Orange, Light Green	Orange, Light Green
Community and Private Assets	Orange	Red	Orange	Red
Cultural Heritage	Green	Green	Yellow	Yellow
Ecology / Nature Conservation	Dark Green	Dark Green	Dark Red	Dark Red
Effects on All Travellers	Light Green	Yellow	Orange	Red
Geology and Soils	Yellow	Yellow	Dark Red	Dark Red
Materials	Orange	Orange	Dark Red	Dark Red
Noise and Vibration	Yellow	Dark Red	Yellow	Dark Red
Townscape and Visual	Dark Green	Orange	Yellow	Orange
Water Environment	Light Green	Light Green	Red	Red

## 5 Summary

Table 5-1 below summarises, for each of the comparisons, which option has lower environmental risks for each environmental topic.

**Table 5-1 Summary of Options Comparison**

<b>Environmental Topic</b>	<b>Bored vs Immersed Tube ('Base' options) – option with lower environmental risks</b>	<b>'Base' options vs 'Shortened' B and C options – option with lower environmental risks</b>
Air Quality	No significant difference	No significant difference
Community and Private Assets	No significant difference	Base option
Cultural Heritage	Bored tunnel	No significant difference
Ecology and Nature Conservation	Bored tunnel	No significant difference
Effects on All Travellers	Bored tunnel	Base option
Geology and Soils	Bored tunnel	No significant difference
Materials	Bored tunnel	No significant difference
Noise and Vibration	No significant difference	Base option
Townscape and Visual	Bored tunnel	Base option
Water Environment	Bored tunnel	No significant difference

From the above comparison, it is clear that:

The immersed tube 'Base' option poses higher environmental risks than the bored 'Base' option resulting from the additional land take and excavation works required for the construction phase, the construction methods which will be used and the vertical alignment of the immersed tube tunnel. The environmental risk and deliverability comparison between the 'Base' options showed higher potential risks with regards to seven out of ten environmental topics and these are related to the following aspects:

- Land take
- Loss of archaeological assets
- Temporary loss of habitats
- Deterioration of water quality, elevated suspended sediments in the river and the loss of intertidal mudflats
- Contamination of controlled waters
- Large volumes of waste and less opportunities to re-use key waste materials

- Changes to water level, flow paths and dynamics and the movement of sediment within the River Thames

The environmental risks associated with the 'Shortened' B and C options are higher than the 'Base' options with regards four environmental topics due to the general design criteria of the reduced cut and cover sections on the south side of the River Thames; the close proximity of sensitive receptors to the open cut road; and construction design changes of Millennium Way Road. The comparison between these two sets of options identified greater environmental risks with regards to:

- Permanent landtake
- Severance
- Noise
- Deterioration in townscape character

Strict maintenance procedures during operation will need to be in place to keep all mechanical and electrical control equipment in the best possible working condition, preventing system failures. The maintenance regimes would be similar in terms of frequency and type but proportionally more maintenance will be required in the 'Base' longer tunnels.

# 6 Drawings

5.1-UA005651-UE31D Air Quality

6.2-UA005651-UE31D Community and Private Assets

6.3-UA005651-UE31D Cultural Heritage

6.4-UA005651-UE31D Effects on All Travellers

6.5-UA005651-UE31D Townscape and Visual Impact

MMD-298348-C-DR-00-ZZ-1004 Bored 'Base' Tunnel Option

MMD-298348-TUN-301 Immersed Tube 'Base' Tunnel Option

MMD-298348-C-DR-00-ZZ-1060\_P1 'Shortened' Immersed Tube Option with onsite casting basin (Option B)

MMD-298348-C-DR-00-ZZ-1050\_P1 'Shortened' Bored Tunnel Option with cross-passages at 350m spacing (Option C)

## 7 Abbreviations

<b>APA</b>	Archaeological Priority Area
<b>AQMA</b>	Air Quality Management Areas
<b>AQS</b>	Air Quality Strategy
<b>BAP</b>	Biodiversity Action Plan
<b>CEFAS</b>	Centre for Environment, Fisheries and Aquaculture Science
<b>CEMP</b>	Construction Environmental Management Plan
<b>DLR</b>	Docklands Light Railway
<b>DMRB</b>	Design Manual for Roads and Bridges
<b>EA</b>	Environment Agency
<b>GIGL</b>	Greenspace Information for Greater London
<b>GLA</b>	Greater London Authority
<b>HS1</b>	High Speed 1
<b>LAQM</b>	Local Air Quality Management
<b>LAARC</b>	London Archaeological Archive and Research Centre
<b>LNR</b>	Local Nature Reserve
<b>MOL</b>	Metropolitan Open Land
<b>MTS</b>	Mayor's Transport Strategy
<b>PLA</b>	Port of London Authority
<b>SAC</b>	Special Area of Conservation
<b>SFRA</b>	Strategic Flood Risk Assessment
<b>SIL</b>	Strategic Industrial Location
<b>SINC</b>	Sites of Importance for Nature Conservation
<b>SPA</b>	Special Protection Area
<b>SPZ</b>	Source Protection Zone
<b>TBM</b>	Tunnel Boring Machine
<b>TfL</b>	Transport for London

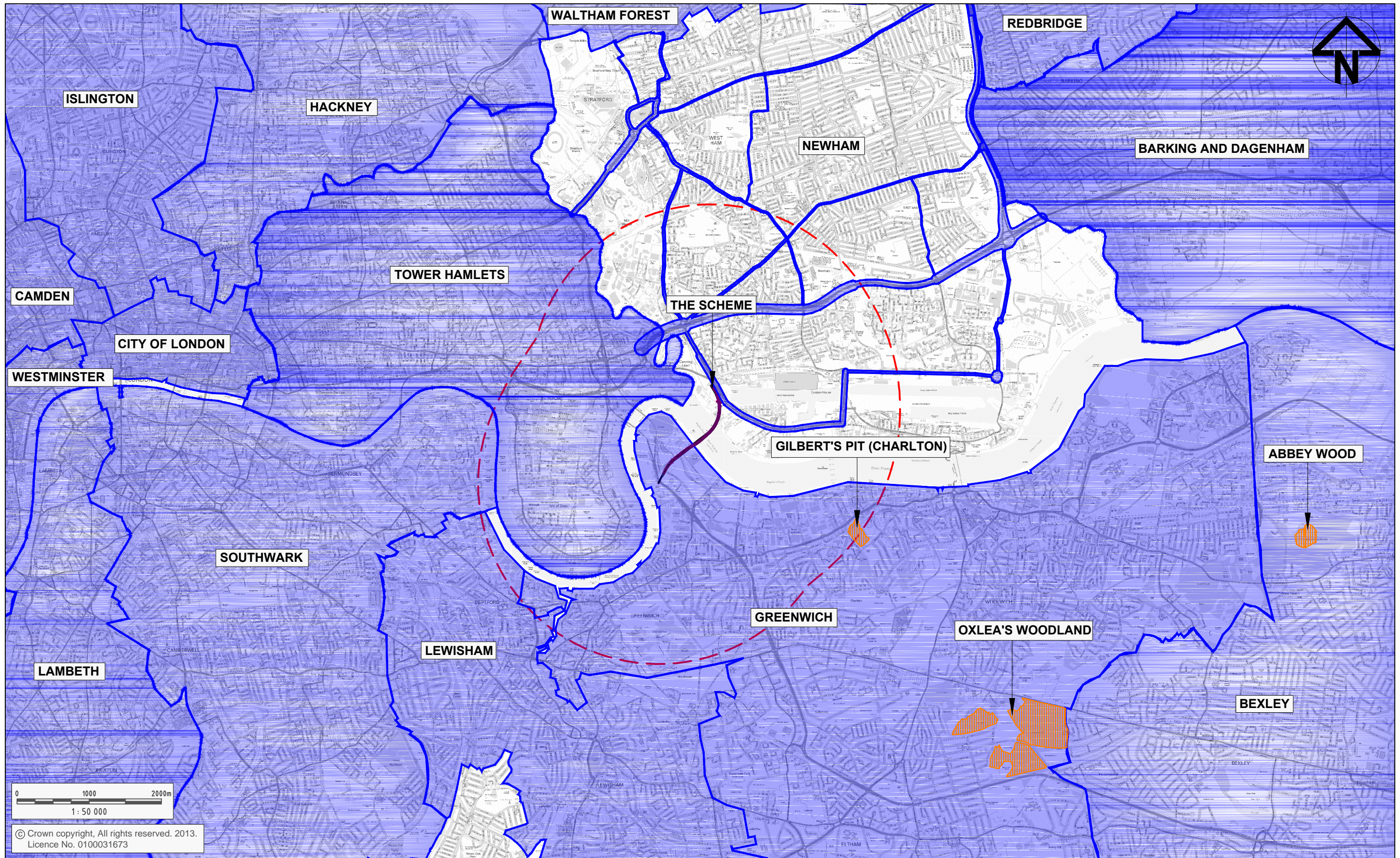


<b>UDP</b>	Unitary Development Plan
<b>WFD</b>	Water Framework Directive
<b>WHS</b>	World Heritage Site
<b>WWII</b>	Second World War

## 8 References

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- Emirates Air Line Cable Car EIA (Mott MacDonald) 2010
- Greenwich Unitary Development Plan (Royal Borough of Greenwich) 2006
- Newham Core Strategy (London Borough of Newham) 2012
- New Thames River Crossing Sustainability Report (TfL) December 2009
- Silvertown Crossing Study, Tunnel Engineering Report (Mott Macdonald) June 2012
- Silvertown Tunnel Engineering, Addendum A (Mott MacDonald) October 2013
- Silvertown Tunnel Further Development of Tunnel Engineering (Mott MacDonald) July 2013
- The London Plan (Greater London Authority) 2011
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01		21 AUG 13
Issue	Description	Date

Notes	
	THE SCHEME
	APPROXIMATE 5km STUDY AREA
	AIR QUALITY MANAGEMENT AREA
	SITE OF SPECIAL SCIENTIFIC INTEREST

Client

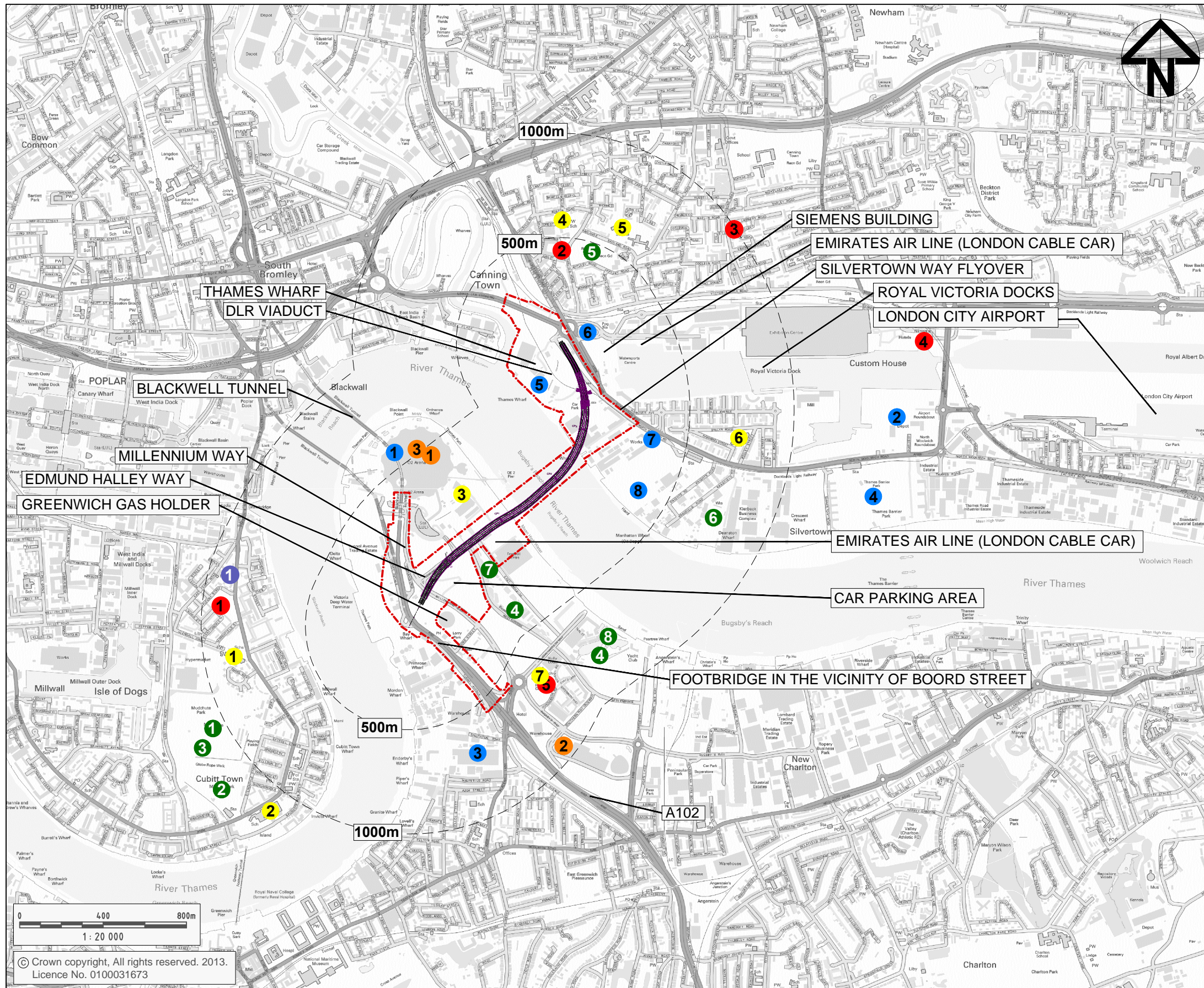
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Grid	GRID	Approver N.HARTLEY
Filename	6.1-UA005651-UE31D-01-AQ.DWG	
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Project	SILVERTOWN TUNNEL
Title	AIR QUALITY CONSTRAINTS MAP GREENWICH/NEWHAM AREA

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Drawing No.	Project No.	Issue
Fig 6.1	UA005651	01





- THE SCHEME
- SAFEGUARDED AREA

**MEDICAL FACILITIES**

- ISLAND MEDICAL CENTRE
- PSU SURGERY
- CUSTOM HOUSE TEACHING & TRAINING PRACTICE
- THE PRACTICE BRITANNIA
- GREENWICH PENINSULA PRACTICE

**EDUCATIONAL FACILITIES**

- CUBITT TOWN JUNIOR SCHOOL
- ST LUKE'S CHURCH OF ENGLAND PRIMARY SCHOOL
- RAVENSBORNE UNIVERSITY
- ST LUKE'S PRIMARY SCHOOL
- HALLVILLE PRIMARY SCHOOL
- BRITANNIA VILAGE PRIMARY SCHOOL
- MILLENNIUM PRIMARY SCHOOL

**ENTERTAINMENT FACILITIES**

- O2 DOME
- CINEWORLD AT O2
- ODEON IMAX

**COMMUNITY CENTRES**

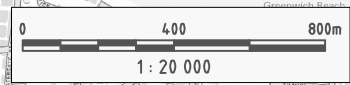
- ISLAND HOUSE COMMUNITY CENTRE

**LAND ALLOCATED FOR DEVELOPMENT**

- PENINSULA MASTERPLAN
- SILVERTOWN QUAYS
- NORTH GREENWICH DISTRICT CENTRE
- MINOCO WHARF (ROYAL DOCKS)
- THAMES WHARF
- ROYAL VICTORIA WEST
- NORTH WOOLWICH ROAD
- THAMESIDE WEST

**OPEN SPACES**

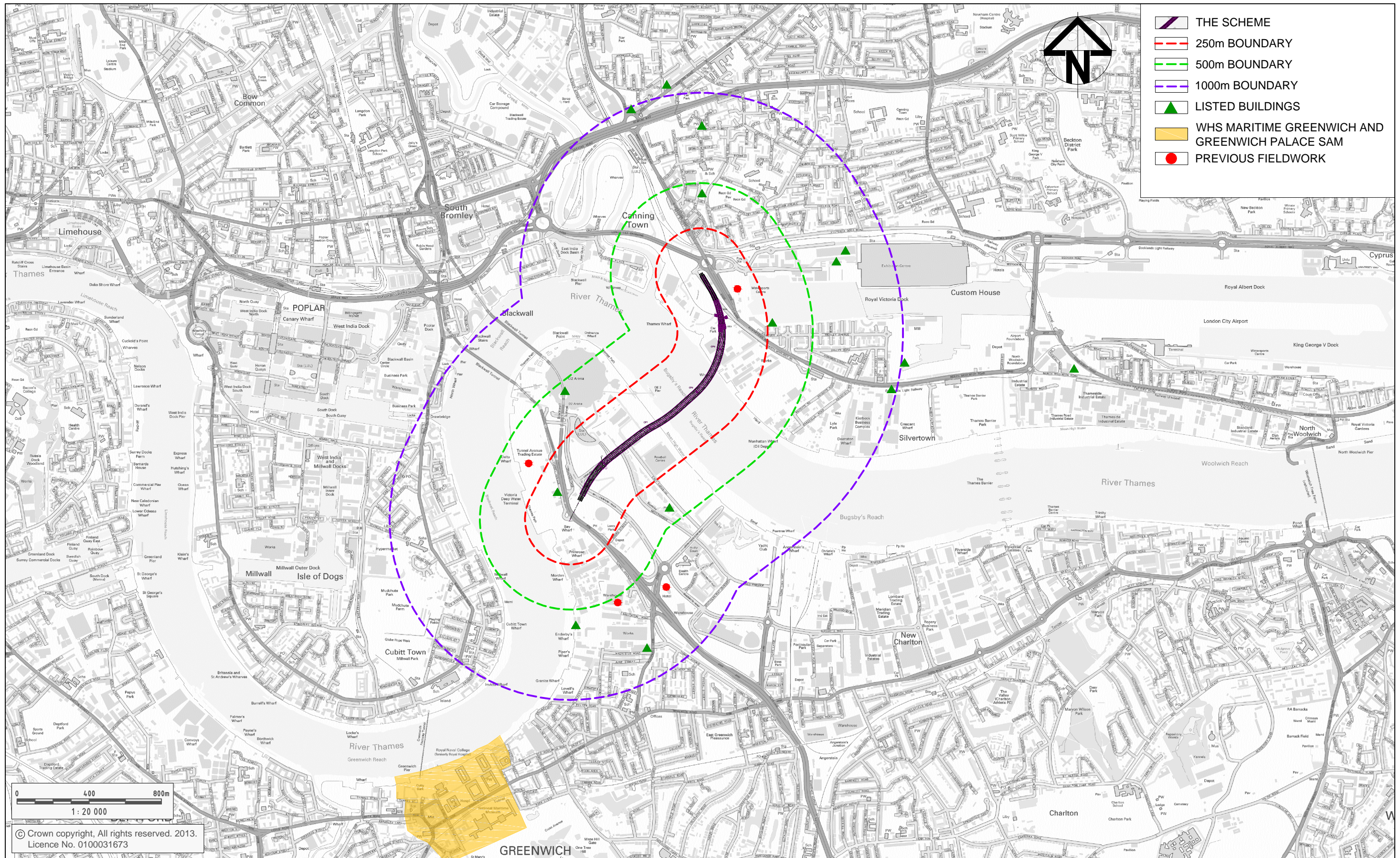
- MUDCHUTE FARM
- MILLWALL PARK
- ST JOHN'S PARK
- METROPOLITAN OPEN LAND ON GREENWICH PENINSULA
- KIER HARDIE RECREATION GROUND
- LYLE PAK
- CENTRAL PARK
- GREENWICH PENINSULA ECOLOGY PARK



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01	Notes	Client	Status EIA SCOPING REPORT		Project SILVERTOWN TUNNEL	Hyder Consulting (UK) Limited 330 Firecrest Court Centre Park Warrington WA1 1RG Tel: +44 (0)1925 800700 Fax: +44 (0)1925 572462
			Transport for London	Scales 1:20,000 Original Size A3 Datum DATUM Grid GRID Filename: 6.2-UA005651-UE31D-01-COMM.DWG		
21 AUG 13	Date				Drawing No.   Project No.   Issue Fig 6.2 – UA005651 – 01	
Issue Description						





Issue	Description	Date
01		21 AUG 13


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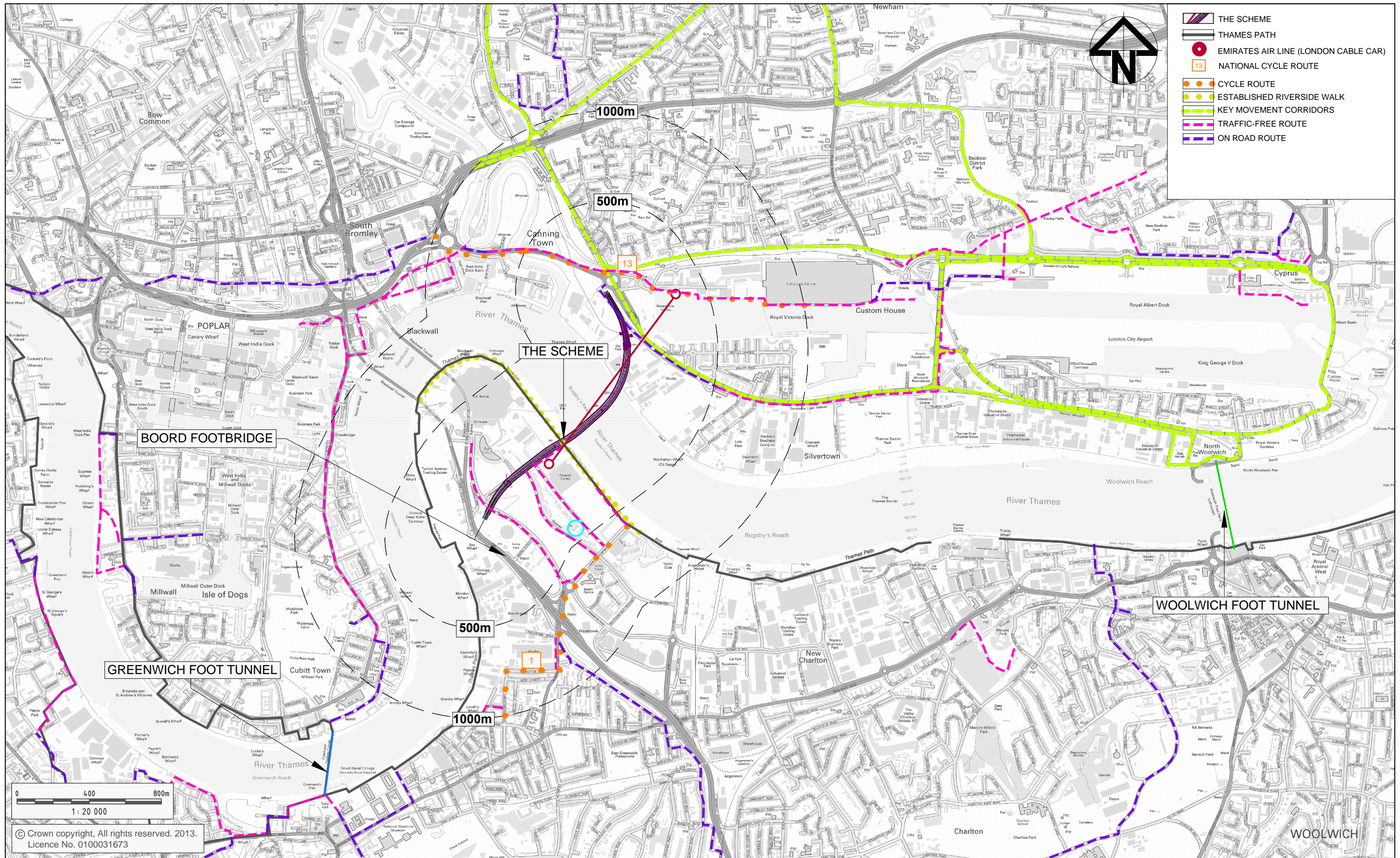
Project	SILVERTOWN TUNNEL
Title	CULTURAL HERITAGE CONSTRAINTS PLAN



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Fig 6.3	UA005651	01





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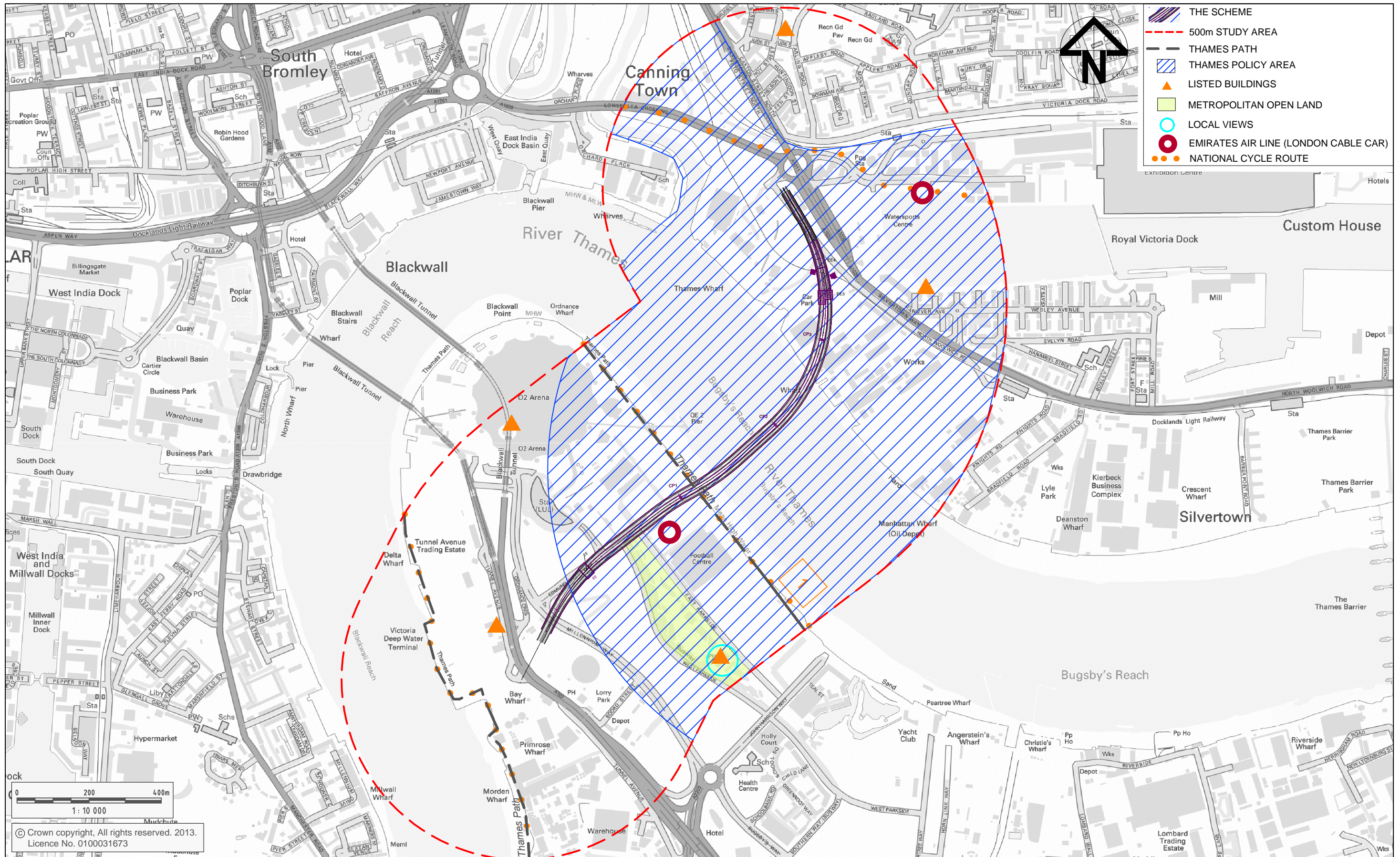
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Project	SILVERTOWN TUNNEL
Title	EFFECTS ON ALL TRAVELLERS

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Issue	Description	Date
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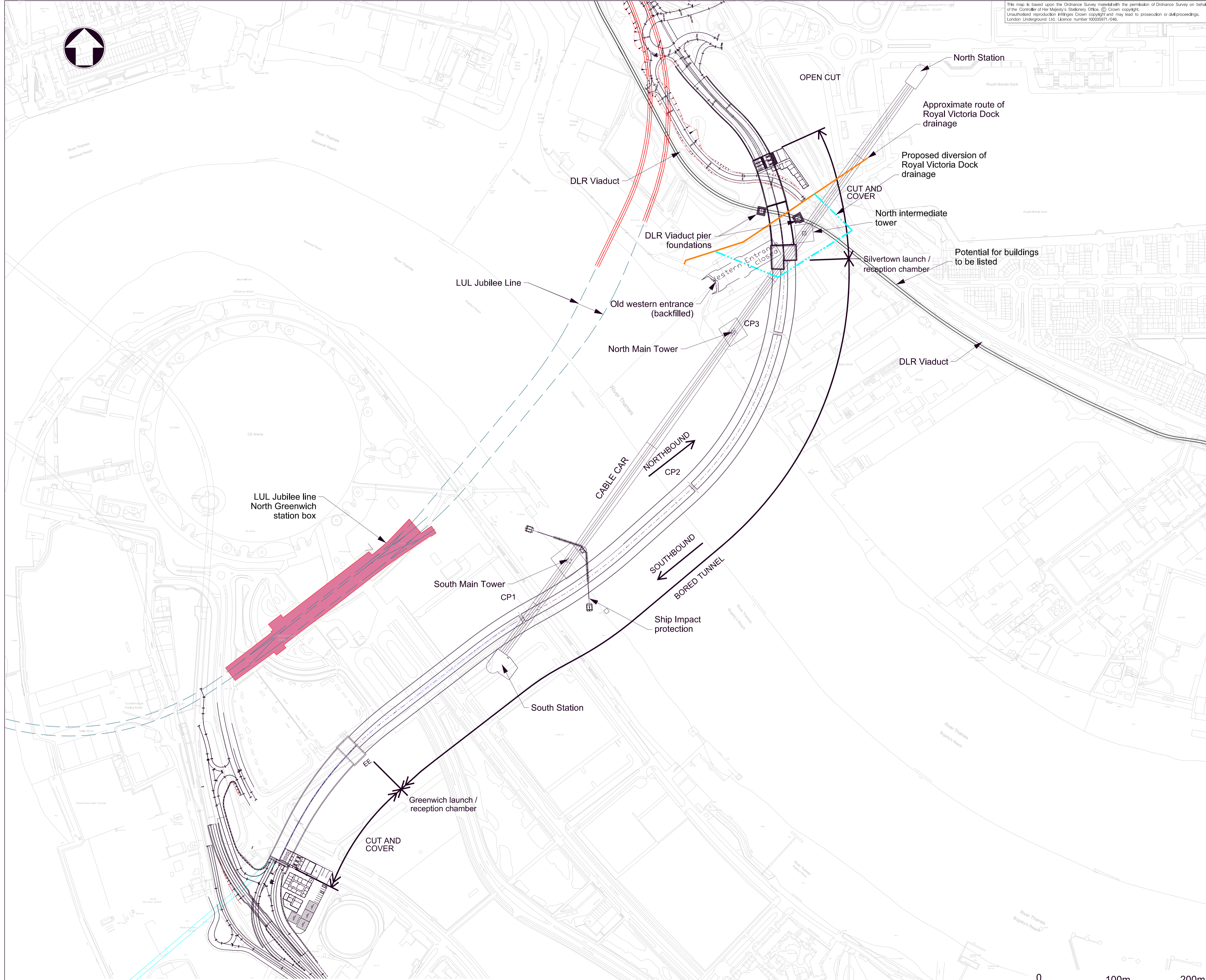
Project	SILVERTOWN TUNNEL
Title	TOWNSCAPE AND VISUAL CONSIDERATIONS

Hyder Consulting (UK) Limited  
 330 Firecrest Court  
 Centre Park  
 Warrington  
 WA1 1RG  
 Tel: +44 (0)1925 800700  
 Fax: +44 (0)1925 572462

Drawing No. | Project No. | Issue  
 Fig 6.5 — UA005651 — 01



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Notes

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Reference drawings

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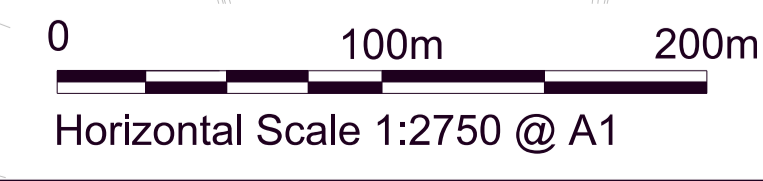
Title

### Silvertown Tunnel Crossing Bored Tunnel Scheme Layout Plan

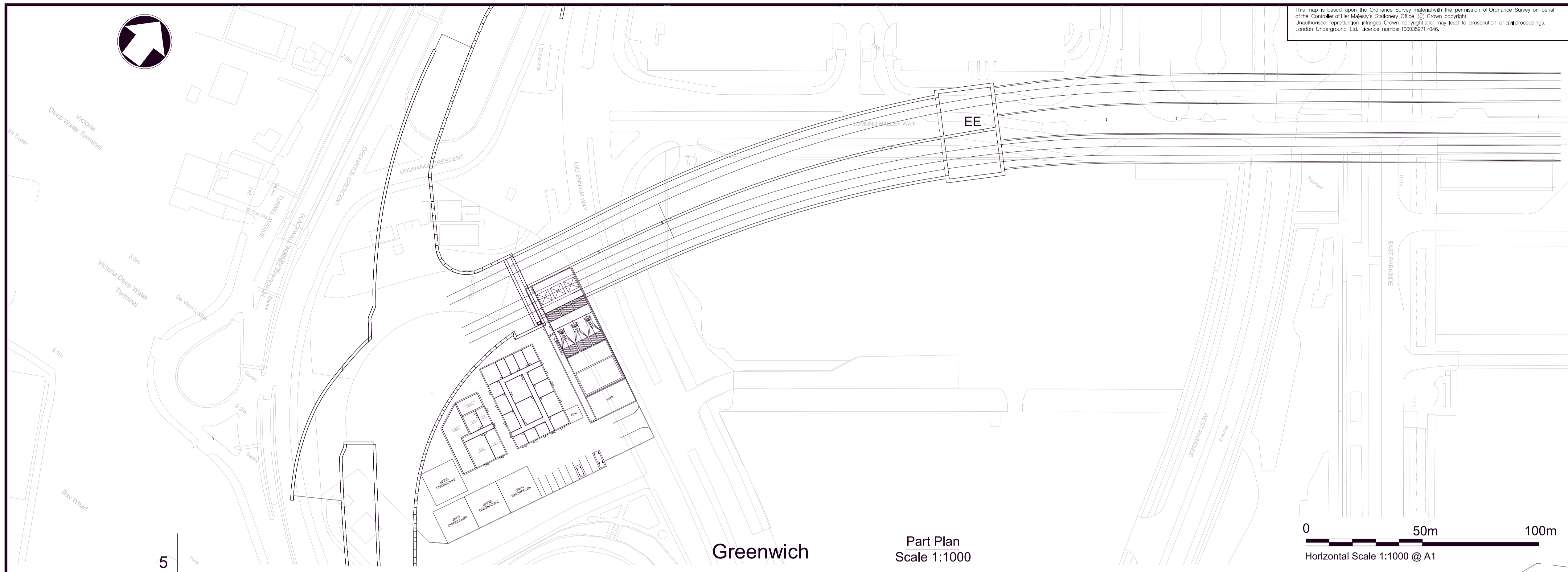
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Drawn	RGH	Coordination	JB
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Drawing Number  
**MMD-298348-C-DR-00-ZZ-1004**

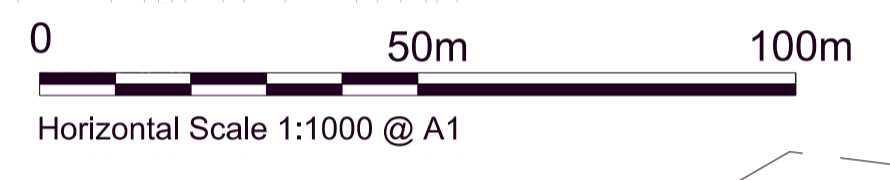
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Formerly Drawing No:- M:287759 New Thames River Crossing/1H Reports and Drawings/1H.03 Outgoing Drawings/working drawings/OPTIONS 2 & 3/DWG/Option 2/287759\_TUN\_1001.dwg — kn56149







Greenwich Part Plan Scale 1:1000



**Notes**  
 1. All dimensions in millimetres unless otherwise stated.  
 2. Do not scale this drawing.

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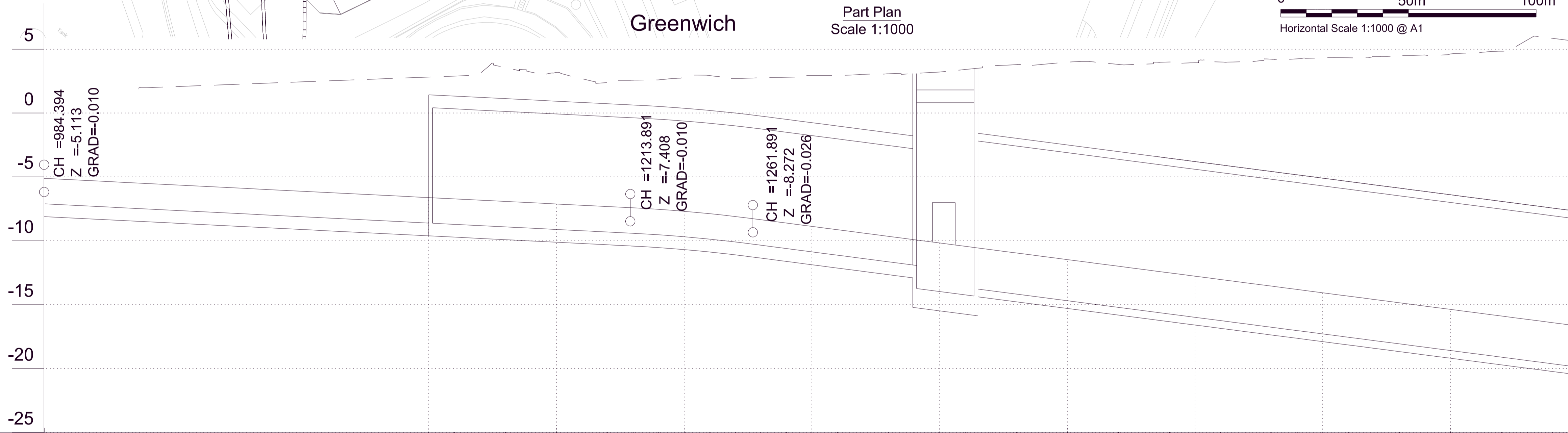
Transport for London  
 50 Victoria Street  
 London  
 SW1H 0TL

**Title**

Silvertown Tunnel Crossing  
 Bored Tunnel  
 Plan and Part Longitudinal Section  
 Sheet 1

Designed	DN	Eng check	JB
Drawn	RGH	Coordination	JB
Dwg check	DN	Approved	MS
Scale at A1	Status	Rev	
As Shown	PRE	P1	

Drawing Number  
**MMD-29348-C-DR-00-ZZ-1006**

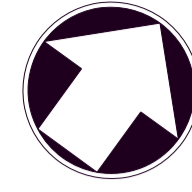


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50.00	-7.119	3.422		
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70.00	-7.319	2.925		
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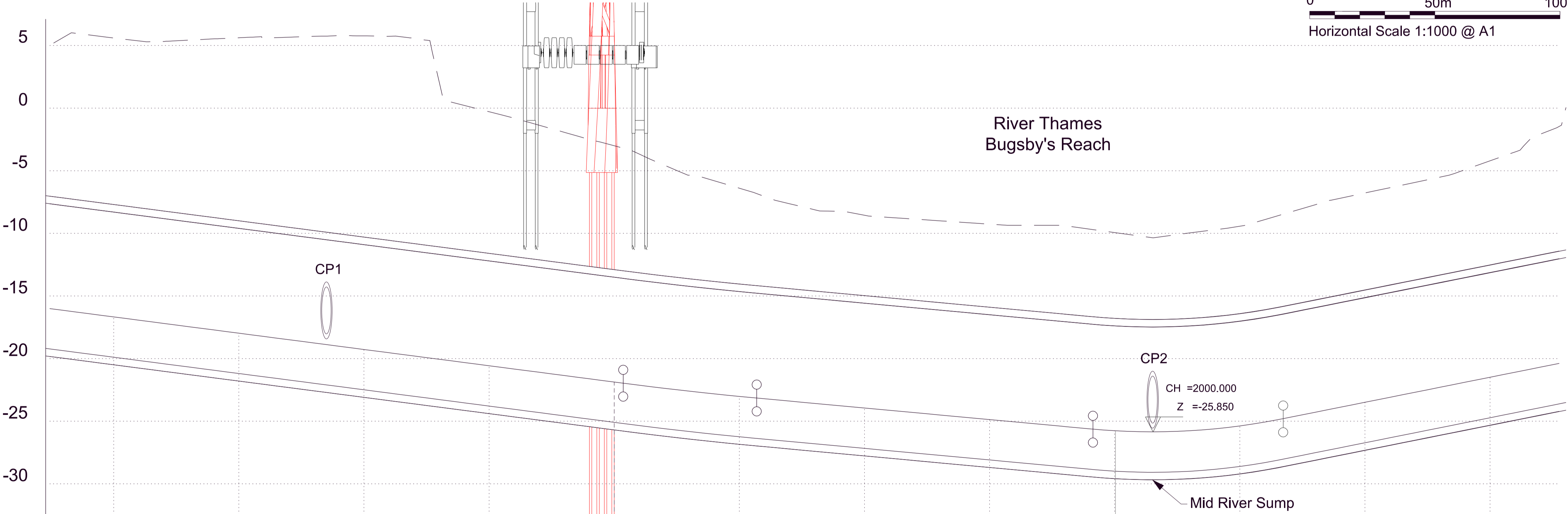
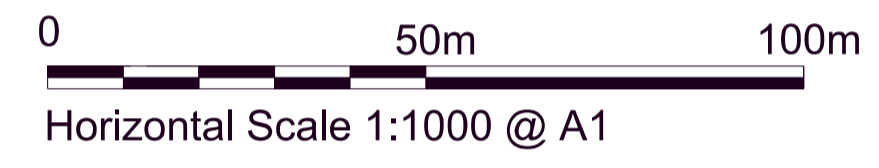
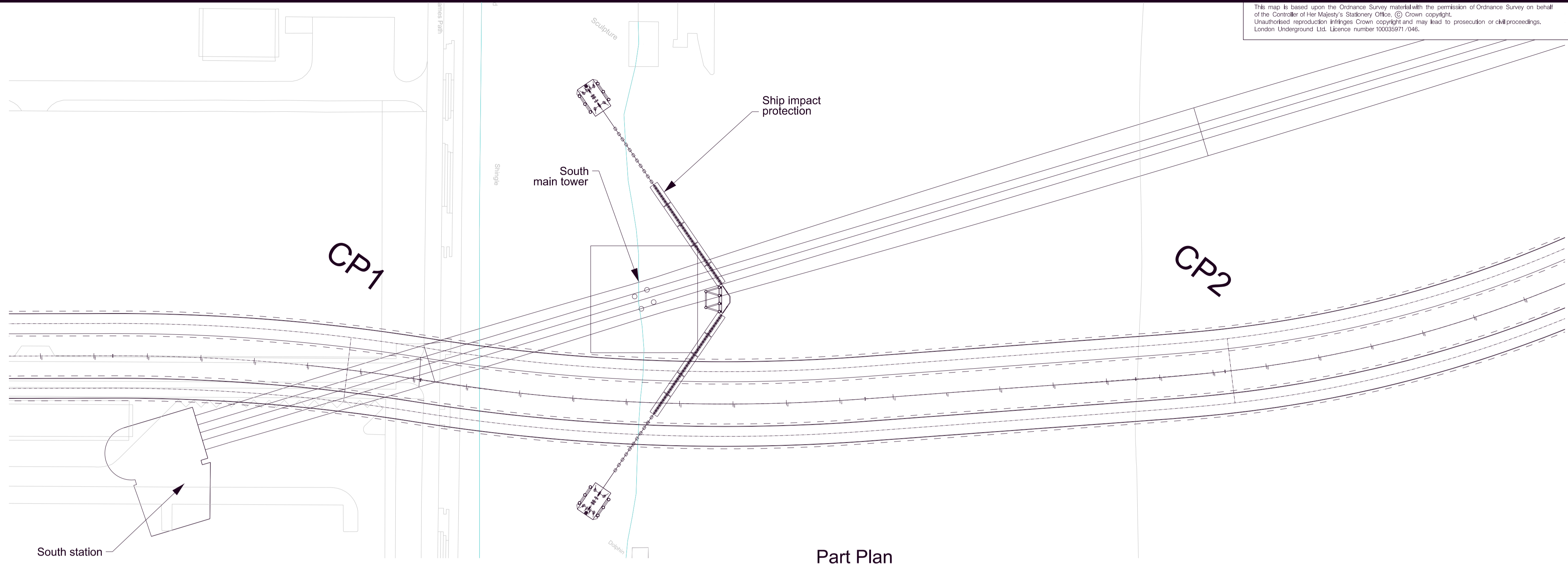
**Scheme Layout Long Section**  
 Horizontal Scale 1:1000 Vertical Scale 1:250

Formerly Drawing No.: P:\Croydon\MMH1Tunnels\29348 Silvertown Tunnel\Drawings\Perament Works\Bored\MMD-29348-TUN-203.dwg Feb 20, 2012 - 3:58PM kn56149





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480.00	-17.453	5.353		
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**Scheme Layout Long Section**

Horizontal Scale 1:1000 Vertical Scale 1:250

**Notes**  
1. All dimensions in millimetres unless otherwise stated.  
2. Do not scale this drawing.

**Key to symbols**

**Reference drawings**

Rev	Date	Drawn	Description	Ch'k'd	App'd
P1	22/04/2013	RGH	PRELIMINARY ISSUE	DN	JB

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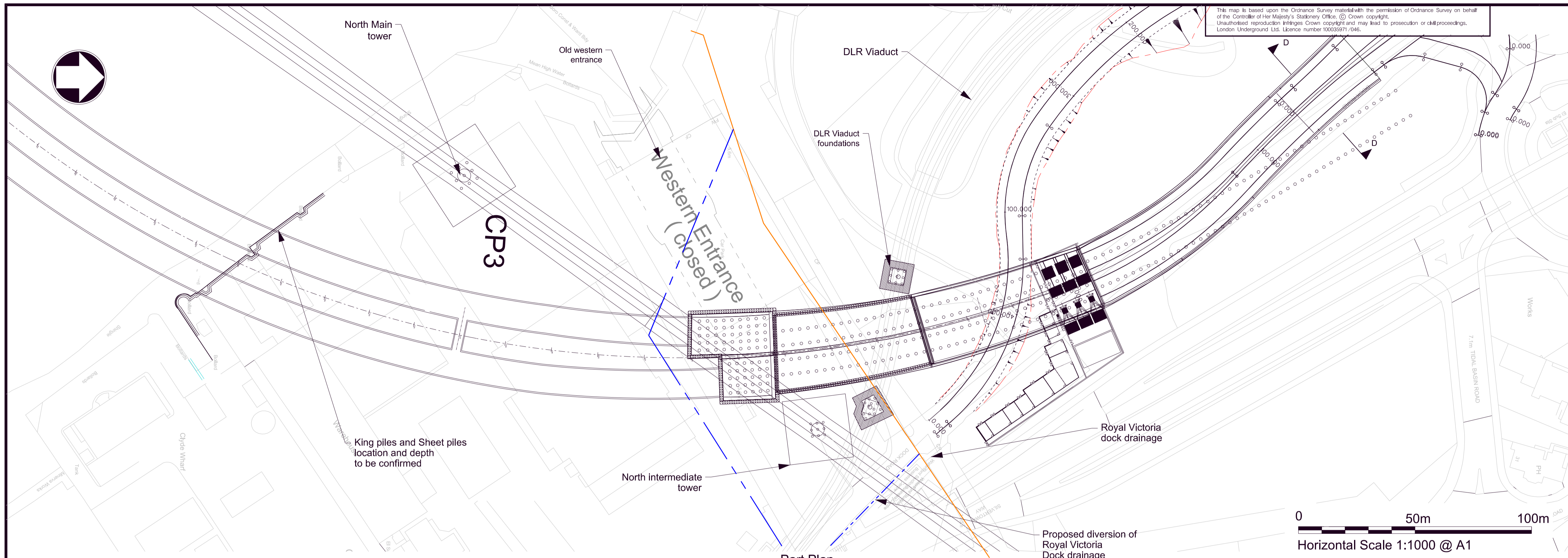
Silvertown Tunnel Crossing  
Bored Tunnel Option  
Plan & Longitudinal Section  
Sheet 2 of 3

Designed	DN	Eng check	JB
Drawn	RGH	Coordination	JB
Dwg check	DN	Approved	MS
Scale at A1	As shown	Status	PRE
		Rev	P1

Drawing Number  
**MMD-298348-C-DR-00-ZZ-1007**

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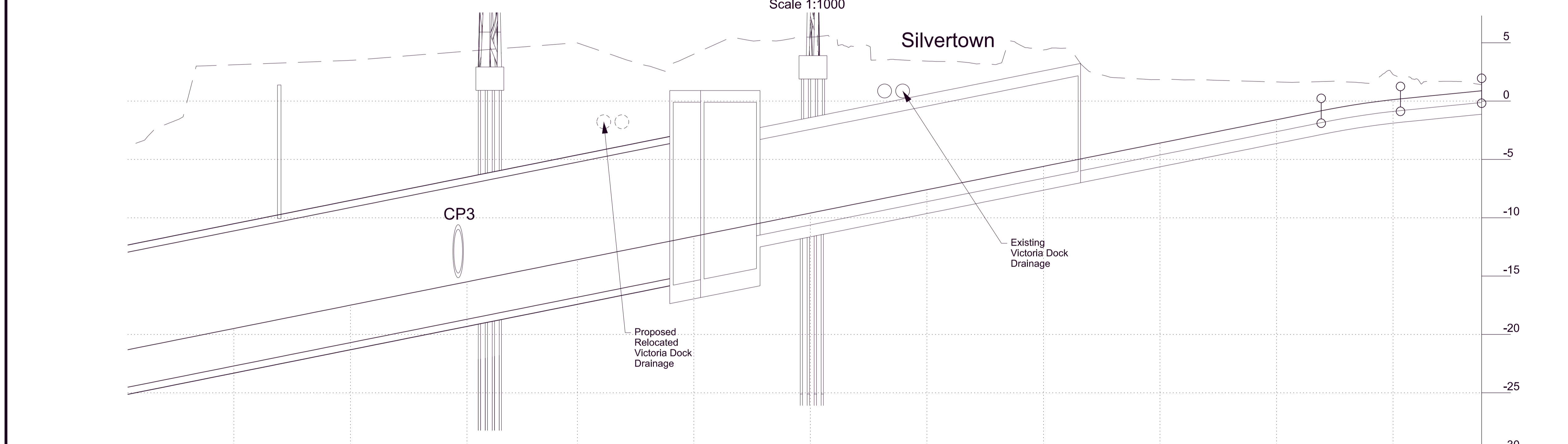


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 Scheme Layout Long Section  
 Horizontal Scale 1:1000 Vertical Scale 1:250

Rev	Date	Drawn	Description	Ch'k'd	App'd
P1	22/04/2013	RGH	PRELIMINARY ISSUE	DN	JB

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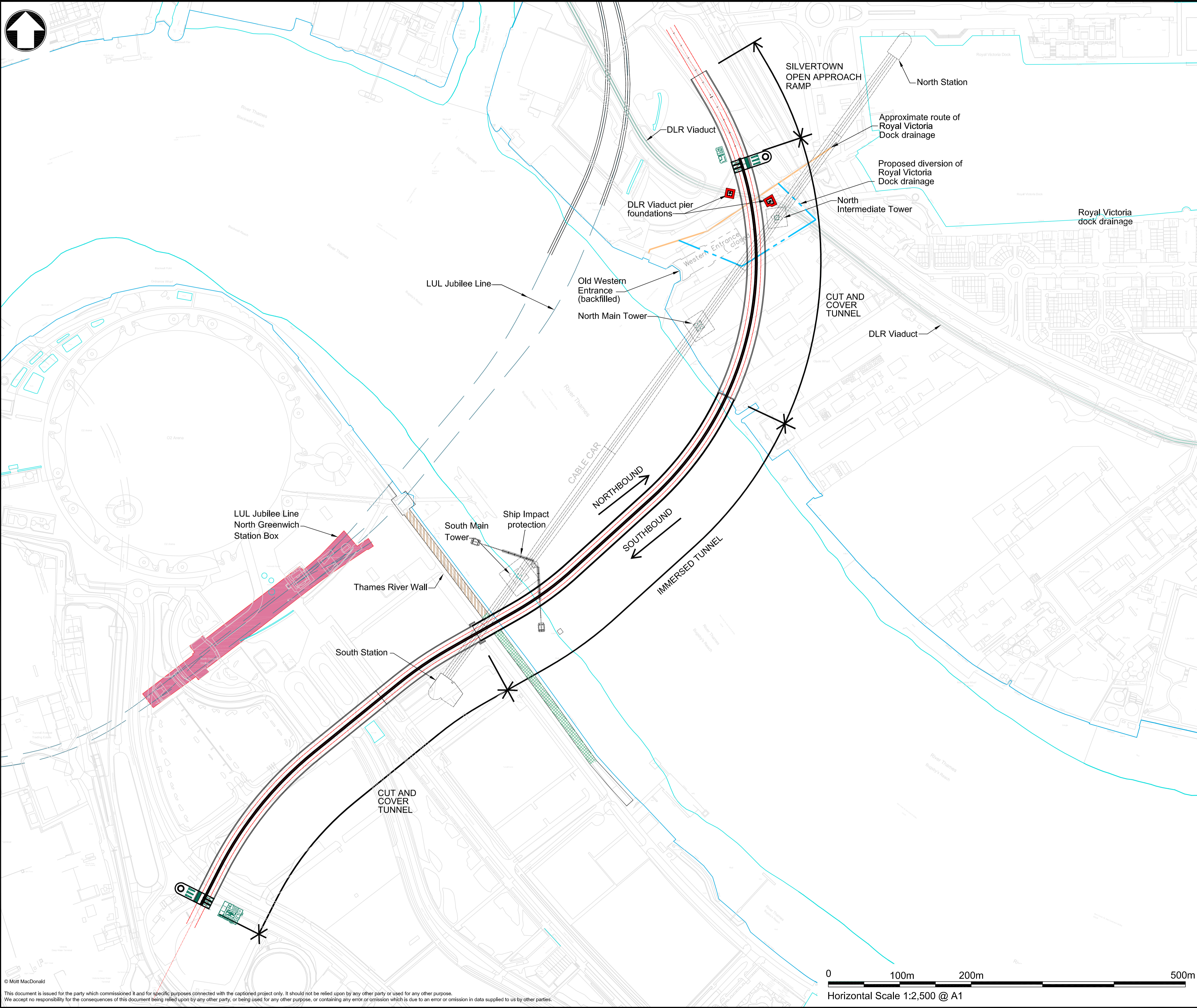
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 Silvertown Tunnel Crossing  
 Bored Tunnel Option  
 Plan & Longitudinal Section  
 Sheet 3 of 3

Designed	DN	Eng check	JB
Drawn	RGH	Coordination	JB
Dwg check	DN	Approved	MS
Scale at A1	As shown	Status	PRE
		Rev	P1

Drawing Number  
**MMD-298348-C-DR-00-ZZ-1008**

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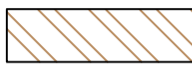


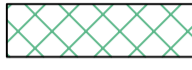
**Notes**

1. Refer to WS Atkins DRG AC1787/C/1450 Rev A for River Wall details.
2. London Cable Car arrangement taken from Mace DRG:

002-CS-URS-DWG-0200011 (10)  
 003-CS-URS-DWG-0200101 (9)  
 004-CS-BHD-DWG-0300002 (C2)  
 004-CS-BHD-DWG-0300002 (P3)  
 005-CS-BHD-DWG-0300002 (P2)  
 006-CS-BHD-DWG-0300002 (P3)

**Key to symbols**

 Option A River Wall. See note 1.

 Option E River Wall. See note 1.

**Reference drawings**

P1	17/02/12	RK	Preliminary Issue	AE	ML
Rev	Date	Drawn	Description	Ch'k'd	App'd



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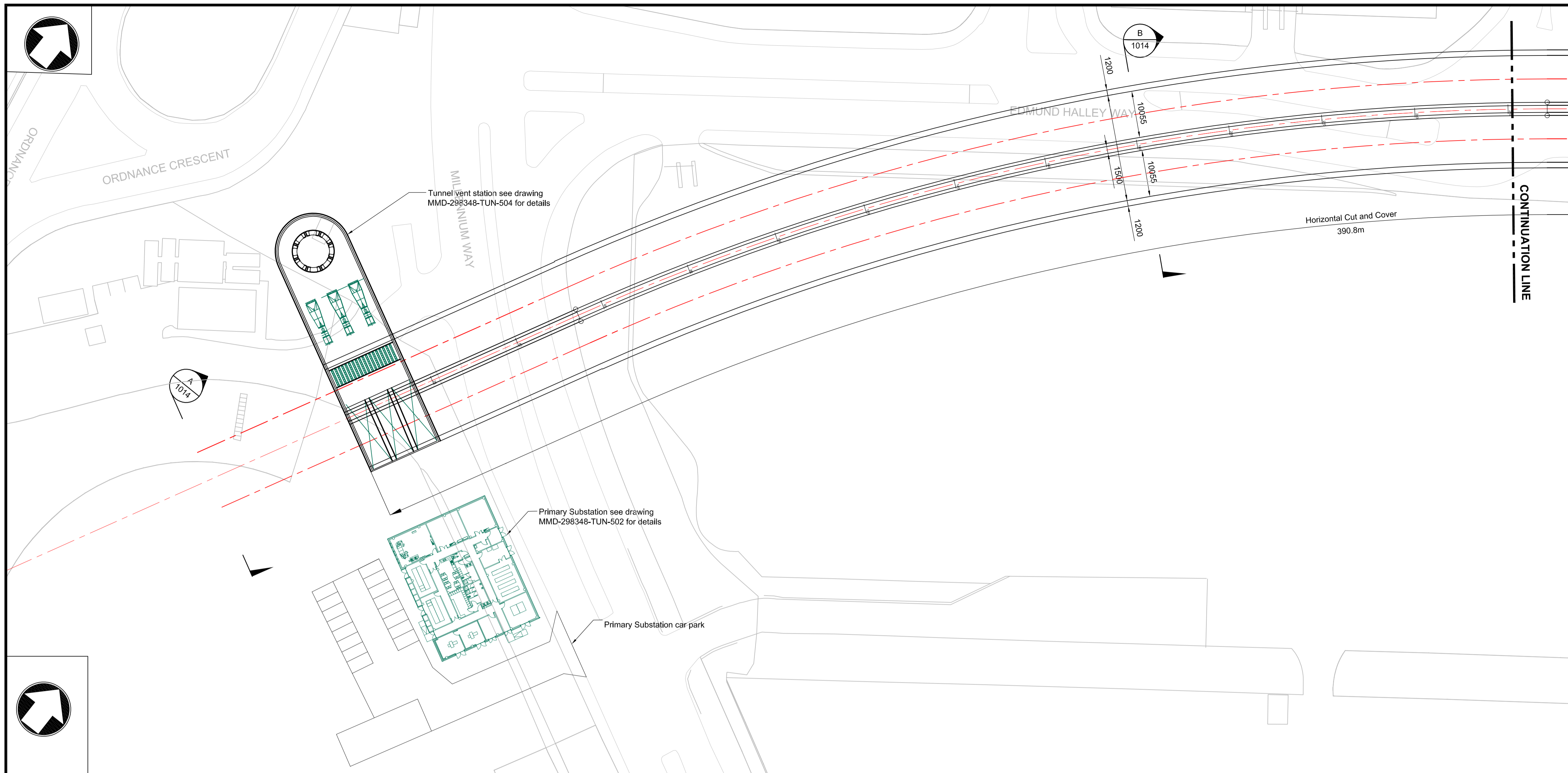
Silvertown Tunnel Crossing  
 Immersed Tunnel Option  
 Tunnel Alignment Plan

Designed	AE	Eng check	JB
Drawn	RK	Coordination	JB
Dwg check	AE	Approved	ML
Scale at A1	1:2500	Status	PRE
Rev	P1		
Drawing Number	MMD-298348-TUN-301		



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Notes

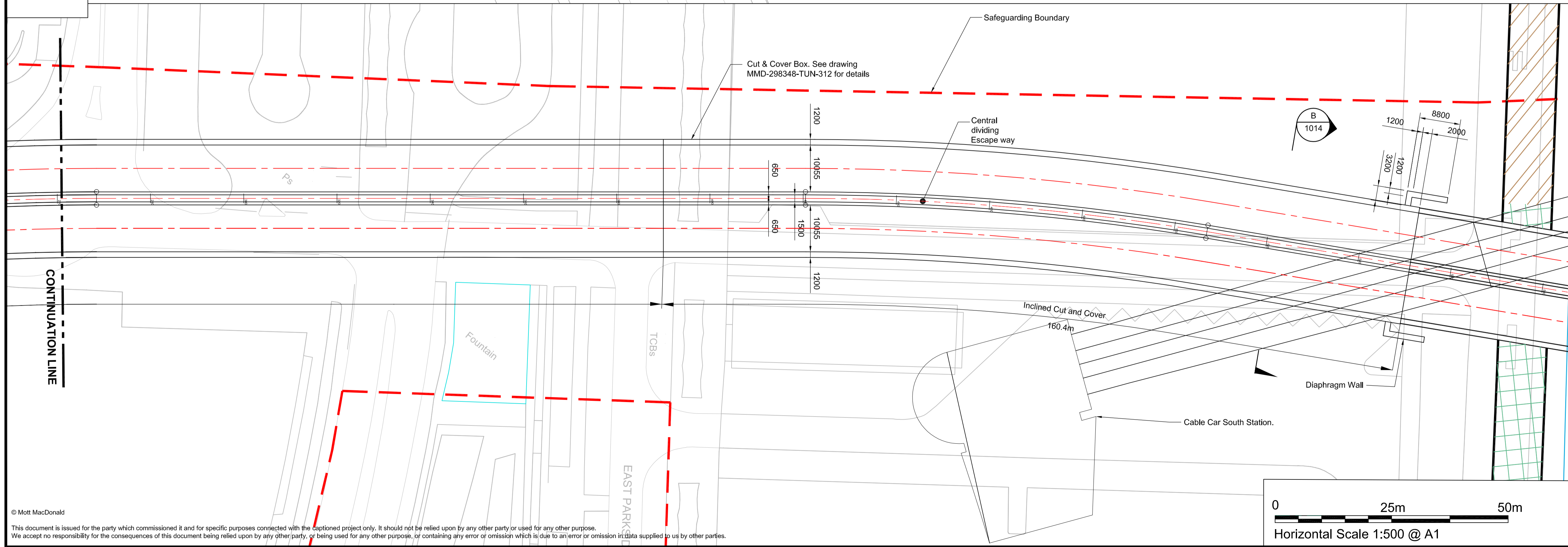
1. All Dimensions are in mm unless noted otherwise.
2. Refer to Drawing MMD-298348-TUN 1012 for sections
3. Refer to Drawing MMD-298348-TUN 1000 for overall tunnel alignment

Key to symbols

- Option A River Wall. See note 1.
- Option E River Wall. See note 1.

Reference drawings

Rev	Date	Drawn	Description	Ch'k'd	App'd
P1	17/02/12	RK	Preliminary Issue	AE	ML



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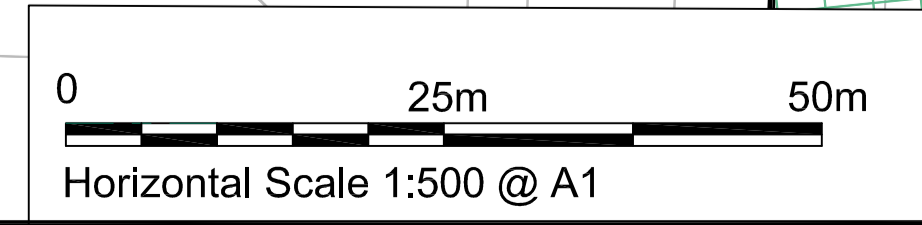
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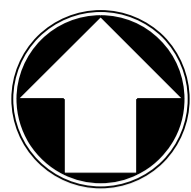
**Silvertown River Crossing  
Immersed Tunnel Option  
Greenwich Approach Structures  
Plan**

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Drawn	RK	Coordination	JB
Dwg check	AE	Approved	ML
Scale at A1	1:500	Status	PRE
Rev	P1		

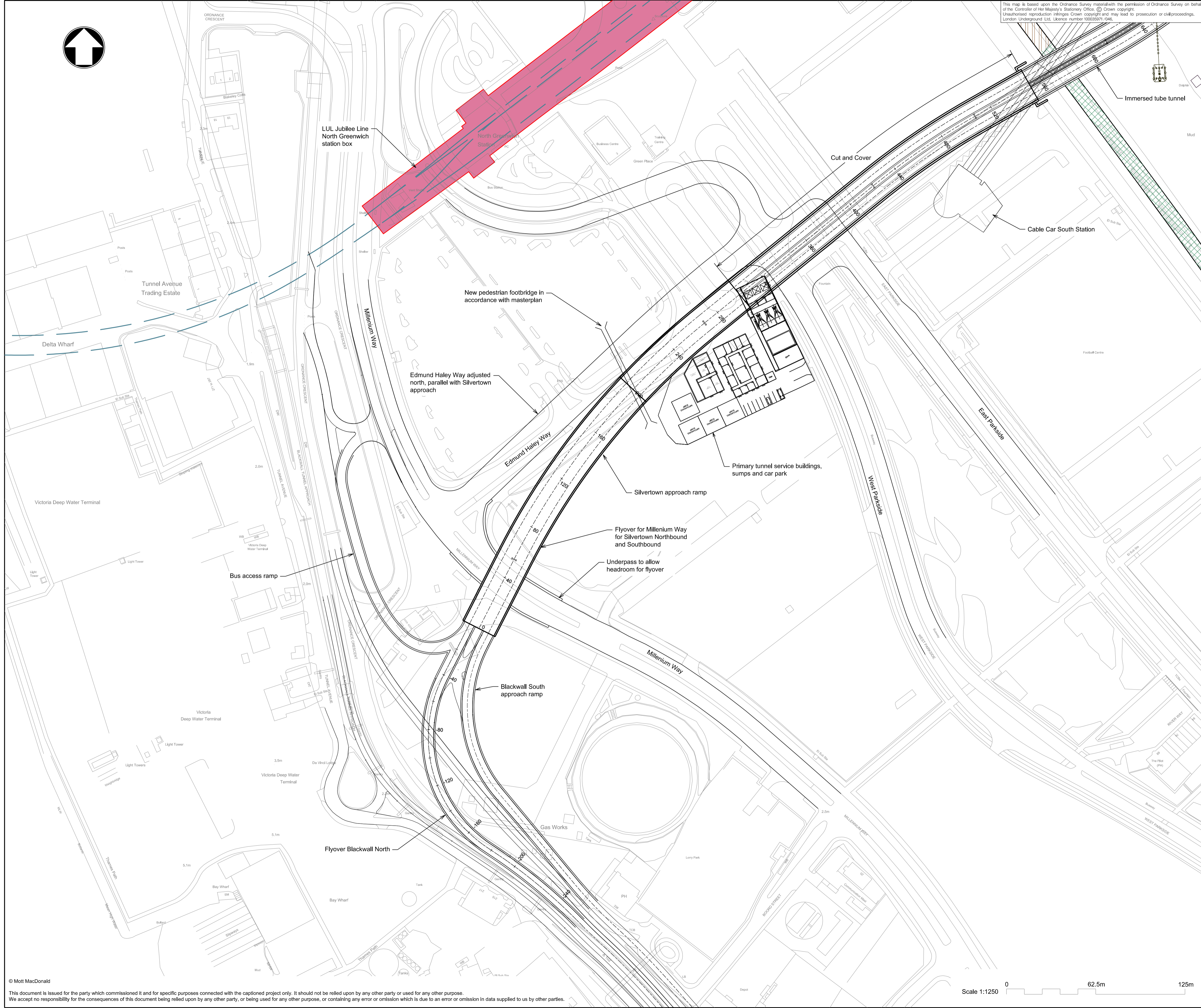
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P1	24.10.13	GB	Preliminary issue	AE	MS



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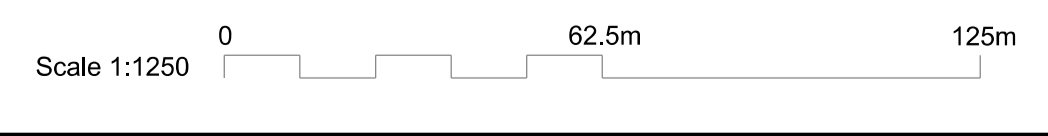
**Client**  
 **Transport for London**  
Transport for London  
50 Victoria Street  
London  
SW1H 0TL

**Title**  
**Silvertown Tunnel Crossing  
Immersed Tunnel  
Option B  
Tunnel Alignment Plan**

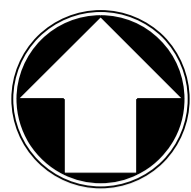
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Drawing Number  
**MMD-298348-C-DR-00-ZZ-1060**

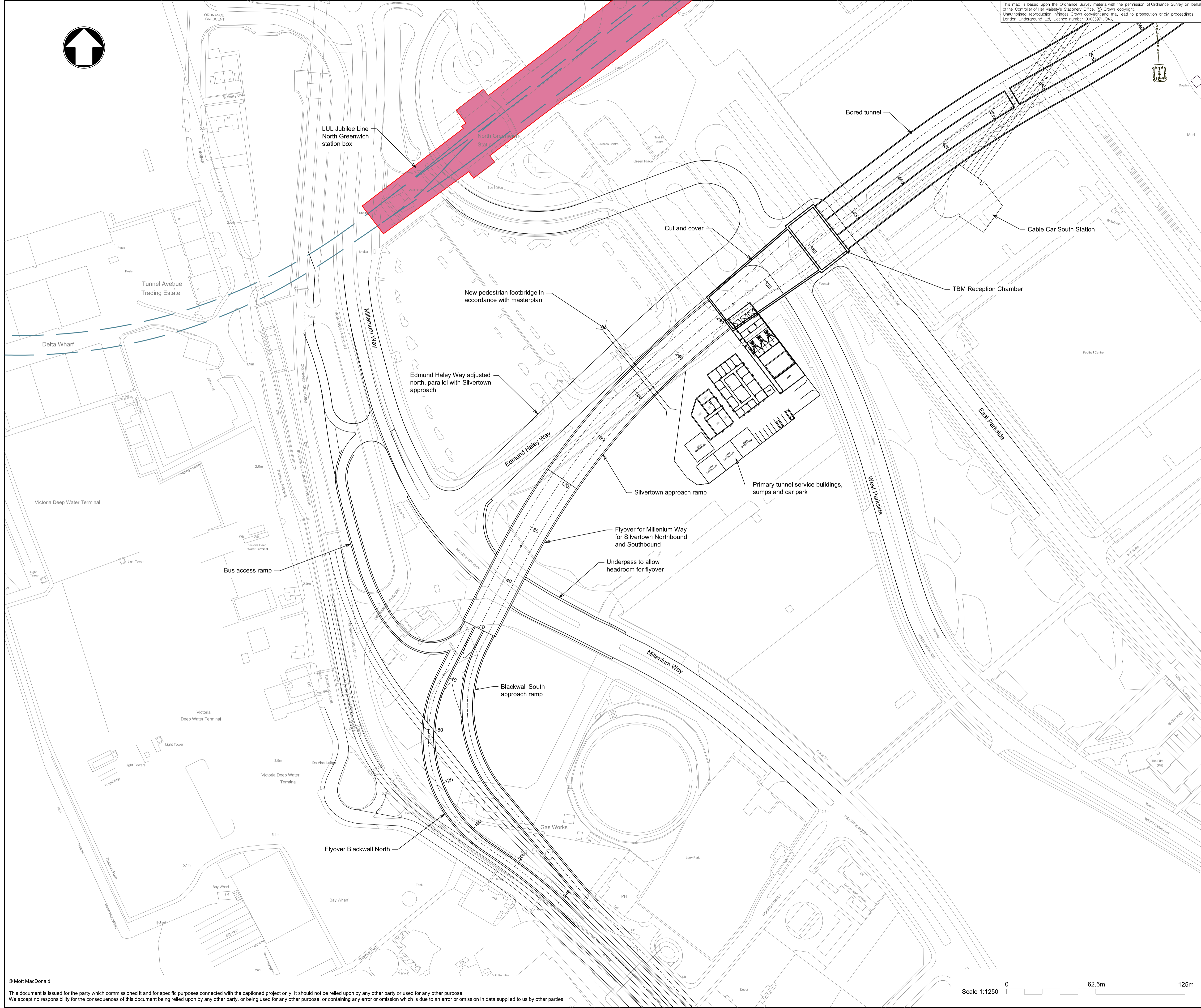
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Formerly Drawing No:- M1267759 New Thames River Crossing/H Reports and Drawings/H.03 Outgoing Drawings/working drawings/OPTIONS 2 & 3/DWG/Option 2/267759\_TUN\_1001.dwg — kn56149







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**Notes**

**Key to symbols**

**Reference drawings**

P1	24.10.13	GB	Preliminary issue	AE	MS
Rev	Date	Drawn	Description	Ch'k'd	App'd



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**Title**

**Silvertown Tunnel Crossing  
Twin Bore Tunnel  
Option C  
Tunnel Alignment Plan**

Designed	AE	24.10.13	Eng check	JB	24.10.13
Drawn	GB	18.10.13	Coordination	JB	24.10.13
Dwg check	AE	24.10.13	Approved	JB	24.10.13
Scale at A1	1:1250		Status	PRE	Rev
					P1

Drawing Number  
**MMD-298348-C-DR-00-ZZ-1050**

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