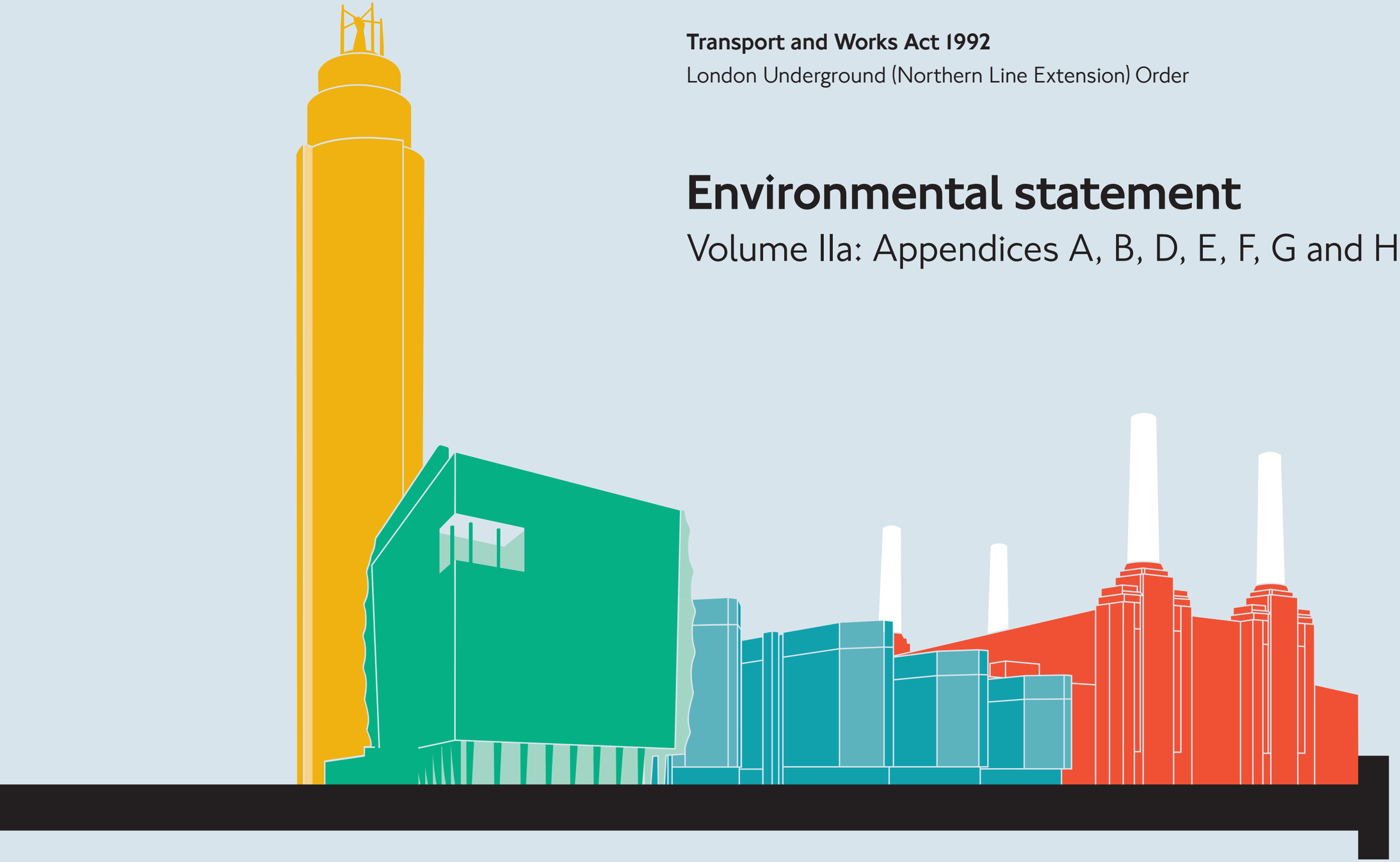
Transport and Works Act 1992

London Underground (Northern Line Extension) Order

Environmental statement

Volume IIa: Appendices A, B, D, E, F, G and H



MAYOR OF LONDON

Transport for London

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Route Option 2

Treasury Holdings UK Limited

May 2011

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1. INTRODUCTION

1.1 Powers are to be sought under the Transport & Works Act 1992 (TWA) for a proposed extension of the London Underground Northern Line (Charing Cross branch) from Kennington to Battersea Power Station, with an intermediate station in the Nine Elms area.

1.2 An order made under the TWA is the usual way of authorising a new railway scheme in England and Wales. In England, applications for TWA orders are made, to the relevant Secretary of State. Applications are made by (or on behalf of) the promoters of the scheme. Promoters of schemes of this kind often need a range of powers to put their scheme into practice. Under the TWA, a promoter can apply to the Secretary of State for an order giving these powers. The powers that can be given in a TWA order can be very wide ranging, for example the promoter of a new railway may need to compulsorily acquire land or have the power to close streets.

1.3 A TWA order does not in itself constitute planning permission, although promoters applying for the order can also ask the Secretary of State to grant planning permission for any development described in the order application. The Secretary of State would only grant planning permission if he/she decided to make the TWA order. The Secretary of State would do so at the same time as the order was made, and may attach conditions to it. The promoter applying for a TWA order may apply for planning permission separately to the local planning authority/authorities before or after the TWA order has been made by the Secretary of State.

1.4 In the case of the proposed Northern Line Extension (NLE), deemed planning permission is to be sought at the same time as the TWA order application.

1.5 Applications for TWA orders must follow the Transport and Works (Applications and Objections Procedure) (England and Wales) Rules 2006. The Rules specify the documents which must be sent with an application. These vary according to the type of order being applied for. The typical documents needed for a proposal involving works are:

- A draft order and an explanatory memorandum;
- A concise statement of the aims of the proposals;
- A declaration as to the status of the applicant;
- A report summarising the consultations carried out by the applicant;
- Plans and sections;
- An Environmental Statement;
- A book of reference, including names of owners, lessees and occupiers of land to be acquired compulsorily;
- The estimated costs of the proposed works; and
- A statement of the funding arrangements.

1.6 The NLE is an Annex II EIA development as described in the European Council Directive 85/337/EEC and its subsequent amendments as set out in paragraph *"10 Infrastructure Projects; (g) Tramways, elevated and underground railways, suspended lines or similar lines of a particular type, used exclusively or mainly for passenger transport."* The NLE could give rise to significant environmental effects (both beneficial and adverse) in terms of its, inter alia, impact on ground conditions, noise and vibration, townscape and visual

effects and other transport impacts and as a result an EIA will be undertaken and an ES submitted in support of the TWA order application. The undertaking of an EIA and preparation of an ES is in accordance with Rule 7(1) of the 2006 TWA Order Rules, which requires an applicant to submit with the TWA order application the applicant's "Statement of Environmental Information". Provision for a Screening Decision is also made under Rule 7, however, the NLE development could give rise to significant environmental effects and so a formal application to the Secretary of State for a screening decision is not intended for the NLE.

1.7 Rule 8(1) of the 2006 TWA Order Rules, allows for the *"the applicant to make a request in writing to the Secretary of State to state his opinion as to the information to be provided in the environmental statement (a "scoping opinion")."* A formal application to the Secretary of State is not intended to determine the scope of the NLE EIA, however, consultation on the EIA scope will be undertaken with the relevant authorities and other consultees directly by the promoter and its agents, primarily through this Scoping Report.

1.8 Scoping forms the first stage of the EIA process. It refers to the activity of identifying those environmental aspects that may give rise to significant environmental effects and which should be considered by the decision maker. Scoping assists the identification of potentially significant effects that could arise following the consideration of the information required for Environmental Statements as set out in Rules 4(1), 11(2) and Schedule 1 of the 2006 TWA Rules. The purpose of this document is to provide the London Borough of Wandsworth (LBW), the London Borough of Lambeth (LBL) and the London Borough of Southwark (LBS) with the opportunity to comment, along with other consultees under Rule 8(4) on the scope of work proposed for the EIA and the contents of the ES. This consultation will be undertaken by the promoter and its agents directly with those relevant consultees and shall follow a 42 day consultation period during which the promoter intends to contact relevant authorities and request comment from them to ensure that the EIA and ES is thorough.

Background to the NLE

1.9 In June 2008, as part of the definition of the Vauxhall Nine Elms Battersea Opportunity Area (VNEB OA) Planning Framework, the Greater London Authority (GLA) completed a development capacity study that identified five development scenarios for the OA, accommodating various levels of residential, retail and employment activity. Transport for London (TfL) then commissioned Sinclair Knight Merz (SKM) to produce a detailed Transport Options Study addressing the main transport issues arising from the five potential GLA development scenarios. A range of potential initiatives were identified to provide varying levels of transport improvement for each of the five development scenarios. In keeping with wider GLA strategic objectives relating to long-term sustainability, the initiatives were focussed on public transport and walking/cycling rather than traffic flow improvements.

1.10 In relation to public transport, three types of scheme were studied by SKM – bus-only, light rail transit (LRT) and the NLE. It is acknowledged by the GLA, TfL, London Underground Limited (LUL) and the landowners and developers within the VNEB OA that only a major new transport infrastructure facility, such as an extension to an underground service, would achieve the significant increase in the Public Transport Accessibility Level (PTAL) necessary to provide sufficient extra capacity to serve major developments within the VNEB OA. In December 2009, the final SKM report concluded that only the NLE could deliver the capacity required to support the GLA's desired development densities in the VNEB OA. As a result, the Mayor of London has recently consulted on a Transport Strategy which supports a developer-led NLE. The GLA has also recently consulted on a Planning Framework for the OA which also supports the NLE as part of a package of transport measures to support regeneration.

1.11 As part of the NLE scheme development process, a number of different route options and sub-options were considered. A formal NLE Public Consultation process was launched in May 2010 to seek views on four specific route (and related station) options. Responses were requested by the end of June 2010.

1.12 Key consultees were consulted on the proposed scope of the EIA in relation to the four BLE options in August 2010. This report is intended to form the basis for a second round of consultation on the proposed scope for the EIA now that route 2 has been selected as the preferred NLE option.

Structure of the Scoping Report

1.13 The remainder of the Scoping Report is structured as follows:

- Section 2 outlines the likely works associated with a proposed extension to the Northern Line;
- Section 3 describes the existing environment in terms of potentially sensitive receptors;
- Section 4 summarises the preliminary list of consultees;
- Section 5 presents issues to be addressed by the EIA;
- Section 6 explains the approach to assessment of impacts considered less significant; and
- Section 7 details the proposed structure of the ES.

2. DESCRIPTION OF THE LIKELY WORKS ASSOCIATED WITH THE NLE

Likely Key Components of the Works

2.1 A Reference Design will be developed which connects the proposed NLE to the existing Northern Line on each side of the Kennington Loop and proceeds to a terminus station at Battersea Power Station - approximately three kilometre (km) distant. The route will pass through an intermediate station in the Nine Elms area. Key permanent components of a route of this nature are likely to be as follows:

Subsurface:

- Running Tunnels – Northbound and Southbound;
- Crossover Structures at the Battersea Power Station Terminus Station and Nine Elms Station;
- Two Step Plate Junctions to facilitate connection of the NLE with the Kennington Loop;
- Overrun Tunnels at the Battersea Power Station Terminus Station;
- Two Ventilation Shafts located just off the Kennington Loop at Kennington Green and within Kennington Park; and
- Combined Intervention & Ventilation Shaft/s: Located in the vicinity of the triangular green bounded by Claylands Road and Trigon Road. The location options for the shaft are indicated in Figure 1.

Above Ground:

- Head buildings associated with the Ventilation Shafts and combined Intervention & Ventilation Shaft/s;
- An intermediate Station in the Nine Elms area (with the provision made for future Over Site Development (OSD); and
- A Terminus Station at Battersea Power Station.

2.2 In addition to the permanent components, temporary Grouting Shafts will be required in the area of the Kennington Loop. Figure 1 at the end of this Report presents the preferred route of the NLE and locations of shafts and stations.

Operational Details

2.3 The following operational details are of relevance to the EIA:

- The Reference Design will assume the introduction of SelTrac CBTC (Communications Based Train Control) signalling system on the Northern Line and that this would be continued onto the Northern Line extension to Battersea Power Station;
- 28 trains per hour along the NLE (maximum design frequency). This frequency equates to a train departure from Kennington and subsequent train arrival at Battersea on average every 129 seconds;
- A 4 to 5 minutes journey time between Kennington and Battersea Power Station;
- At any one time under normal operating conditions, it is likely, given the estimated journey time of 4 to 5 minutes between Kennington and Battersea, there might be three trains in each direction or six on the extension in total; and
- Maximum line speed for the route has been established as 80 kilometres per hour (kph), or approximately 50 miles per hour (mph).

3. THE EXISTING ENVIRONMENT

Potential Environmental Sensitivities/Sensitive Receptors

3.1 As part of the 2008 Preliminary Environmental Assessment (PEA) for the proposed NLE, a land use classification exercise was undertaken across a defined study area to inform the PEA in relation to land uses and potentially sensitive receptors. Classification of land uses was informed by aerial photography, ordnance survey maps, local planning policy documentation, in addition to a ground truthing exercise.

3.2 The study area identified for the purposes of the PEA covered the broad area around the Route Options/alignments under consideration at the Engineering Feasibility and Business Case stage of the project. The study area provided a context for the PEA. The study area defined for the PEA was roughly trapezoidal in shape, following the Thames foreshore along its northern edge. The southwest corner was placed at National Grid Reference (NGR) 528695, 176700, and the northeast corner at NGR 532010, 178540.

3.3 It should be noted that whilst the above detailed study area served as context for the PEA and had enabled identification of potentially sensitive receptors for this EIA Scoping Report, the study areas for the EIA submitted in support of the TWAO application will be redefined and specific to the technical aspects addressed in the ES e.g. air quality, noise & vibration, ecology, archaeology etc.

3.4 The area around Kennington Station is largely residential in use supported by other uses including care homes, allotments, churches, community centres, hospitals and clinics, libraries, schools and colleges. In addition, there are several areas of miscellaneous open space and several parks and gardens including Kennington Park, located to the south of the Kennington Station, and Kennington Green that provide a valuable amenity resource for both the local residents and local ecology.

3.5 The western part of the area where the NLE is located is formed primarily of land within the VNEB OA and is light industrial in nature punctuated by pockets of commercial/office space.

3.6 When undertaking an EIA it is important to identify which receptors will be considered as part of the assessment. Previous studies and consultations undertaken at the Engineering Feasibility and Business Case stage of the project (2008/09), in addition to the August 2010 first round of EIA scoping, have revealed the potential sensitive receptors to the works, which are summarised below (further discussion on sensitive receptors is given for each technical assessment later in this report):

- **Kennington Park**, a registered **Historic Park and Garden** and **Local Nature Reserve**;
- **Kennington Park Conservation Area**;
- **Kennington Green**, a **Scheduled London Square**;
- **Hanover Gardens,** Kennington;
- **Kennington Green Conservation Area**;
- **Built heritage and listed buildings** associated with Conservation Areas;
- **St Mark's Conservation Area**;
- **The Oval Cricket Ground**;
- **The Kennington Gas Holders**;
- Important **local views**;
- **Residential properties, care homes, allotments, churches, community centres, hospitals and clinics, libraries, schools and colleges** etc;
- Sub-surface **archaeological deposits** in the footprints of any proposed shaft and station locations;
- Subsurface **Thames Water Utilities Limited (TWUL) Ring Main**;
- Subsurface existing **Northern and Victoria London Underground Tunnels**;
- **Network Rail assets**;
- **Local ecology** including trees, bats and birds within Kennington Park;
- The **River Thames**, its foreshore ecology and Site of Metropolitan Importance for Nature Conservation (SMI);
- **Ground conditions** including the shallow and deep groundwater aquifers;
- **Pedestrians, cyclists, the business community and tourists**;

- **EDF Energy cable tunnel,** the **TWUL Heathwall Sewer (new line)** and **the South-west Storm Sewer**; and
- **Other subsurface utilities and services**.

4. CONSULTATION

4.1 An EIA scoping report detailing the four route options was prepared in August 2010, and a first round of consultation was undertaken, with the following organisation consulted;

- The LBW;
- The LBL;
- The LBS;
- EDF Energy (EDFE);
- Transport for London (TfL);
- London Underground Limited (LUL);
- The Mayor of London and The Greater London Authority (GLA);
- English Heritage (EH) & The Garden History Society;
- The Health and Safety Executive (HSE);
- The EA;
- Natural England;
- The PLA;
- Network Rail;
- Thames Water Utilities Limited (TWUL);
- The Oval Cricket Ground and The Duchy of Cornwall; and
- Greenspace Information for Greater London (GiGL) – formerly the London Wildlife Trust (LWT).

4.2 Opinions were received from the following consultees;

- The Environment Agency (EA);
- London Borough of Wandsworth (LBW);
- London Borough of Southwark (LBS);
- The Port of London Authority (PLA);
- Thames Water Utilities Limited (TWUL);
- English Heritage (EH); and
- Natural England (NE).

4.3 LUL noted in their email (dated 11/10/10) that consultation should be undertaken with Westminster City Council (WCC), (the Planning Authority north of the LBW), as there may be cumulative effects on the City of Westminster. The email also recommended consultation with the Office of the Rail Regulator (ORR). Additionally, LUL also noted that a definition of local residents and owners would be helpful.

4.4 The opinions on the scope of the EIA are included in Appendix A: Consultation Responses.

4.5 The process of consultation is important to the development of a thorough, balanced and relevant ES commensurate with the NLE proposals. Views of the relevant authorities serve to focus the environmental studies and help to identify specific issues that require further investigation. Consultation is an ongoing process as part of design development.

4.6 The following organisations will be further consulted, either on the evolution of the scheme design or on the preliminary assessment of potential environmental effects and so the scope of the EIA:

- LBW;
- LBL;
- LBS;
- London Borough Camden;
- The City of London Corporation;
- Westminster City Council;
- EdF Energy;
- TfL;
- LUL;
- Mayor of London/GLA;
- English Heritage;
- Garden History Society;
- Health and Safety Executive;
- ORR;
- Environment Agency;
- Natural England;
- Port of London Authority;
- Network Rail;
- Thames Water;
- Oval Cricket Ground;
- Greenspace Information for Greater London;

- Opportunity Area occupiers and landowners;
- London Travelwatch;
- The Open Spaces Society;
- Auto-Cycle Union;
- British Horse Society;
- Byways and Bridleways Trust;
- The Rambler's Association;
- The British Driving Society;
- The Cyclist's Touring Club; and
- The Royal Mail.

Public Consultation

4.7 A first round of public consultation was undertaken in May 2010 and the conclusions were that an overwhelming majority of local residents, land owners and other stakeholders favoured route two as their preferred route choice. There were a number of reasons why route two was the most popular. Firstly, it offers two new stations for the Nine Elms area. Secondly, the mid station was viewed as being the best positioned station in terms of it being able to serve the two largest already existing towards the eastern end of the Nine Elms area. The NLE will also enable potential large scale development opportunities to come forward in the same vicinity. Respondents also consistently asked for the extension to be built quickly, in conjunction with the development of Battersea Power Station.

4.8 A second round of public consultation is planned for May 2011, for which leaflets and questionnaires will be distributed to businesses and residents who are likely to be affected or have an opinion on the NLE. The leaflets present the proposed route and the shaft options and the questionnaire provide an opportunity for the public to provide feedback. In addition, three public exhibitions will be undertaken. The public exhibitions will take place along the proposed NLE route.

5. ISSUES TO BE ADDRESSED BY THE EIA

Introduction

5.1 The ES will be prepared in accordance with statutory requirements and current guidance for EIA together with applicable national and international legislation for the EIA process. In particular, the ES will be prepared with due consideration to:

- EU Directive (85/337/EEC) on Environmental Impact Assessments and its amendments Community Directives 97/11/EC and 2003/35/EC;
- Transport and Works Act 1992;
- Transport and Works (Applications and Objections Procedure) (England and Wales) Rules, 2006;
- The Department of Transport - A Guide to Transport and Works Act Procedures 2006

- Department of Environment, Transport and the Regions (DETR) Circular 02/99 Environmental Impact Assessment;
- Department for Communities and Local Government (DCLG), 2006; Amended Circular on Environmental Impact Assessment: A consultation paper, June 2006;
- Preparation of Environmental Statements for Planning Projects that require Environmental Assessment: Good Practice Guide, Department of the Environment (DoE) 1995;
- Department for Communities and Local Government, June 2006; Environmental Impact Assessment: A Guide to Good Practice and Procedures;
- Institute of Environmental Management and Assessment (IEMA) Guidelines for Environmental Impact Assessment, 2004; and
- Office of the Deputy Prime Minister (ODPM) Environmental Impact Assessment: A Guide to Procedures, 2001.

5.2 For the EIA to be an effective decision-making tool, the ES needs to focus upon potentially significant environmental issues. The following sub-sections describe the works proposed to fulfil the requirements of the EIA process/legislative drivers.

Methodology and Cumulative Impact Assessment

5.3 The EIA will address the direct impacts of the NLE works on the environment in addition to the indirect, cumulative, short, medium and long term, permanent, temporary, beneficial and adverse impacts arising from the NLE works.

5.4 LBW commented in their letter dated 29/09/10 that the mitigation potential of environmental impacts should be a theme permeating all areas of the ES, as should the potential impact on future development sites.

5.5 The main mitigation measures envisaged in order to avoid, reduce or remedy significant adverse impacts will be described and will be a key theme permeating all areas of the ES as requested in LBW's letter of 29/09/10. The concluding chapters will provide a summary of the cumulative and residual impacts of the NLE.

5.6 The following assessments will be presented within the ES:

- **Existing baseline**;
- **Impacts associated with the proposed NLE throughout site preparation, excavation and construction,** where relevant focusing on the peak period of excavation and construction;
- **Impacts associated with the operational NLE** (i.e. at the point of opening); and
- A **Cumulative Impact Assessment** which will assess the impacts associated with the NLE, in addition to:

  a. The development of the entire VNEB OA, as per the VNEB OAPF, assumed to be 2031;

  b. Other significant schemes outside of the VNEB OA but within 1km of the works centreline which have full planning consent, those with a resolution to grant consent or schemes under construction. A provisional list of these schemes is provided below. To be agreed between DP9, BDB, URS and TH

- Battersea Power Station;
- United States Embassy;
- 143-161 Wandsworth Road;
- St George's Wharf and Vauxhall Tower;
- Land at St George's Wharf;
- Kennington Oval;
- Parliament House, 81 Black Prince Road;
- Hampton house, 20 Albert Embankment;
- Wah Kwong House, 10 Albert;
- 1 Glyn Street; and
- Former Castle Industrial Estate.

  c. Further to this list, there may be additional schemes outside of the 1km distance that shall be considered particularly in connection with the Transport Assessment, and Townscape, Conservation & Visual Impact Assessment. These assessments consider impacts over a wider area than Volume I of the ES. Justification of the reasons behind including other schemes within the aforementioned studies will be provided; and

  d. Other major LUL works on the London Underground network.

5.7 The above sets out the general approach to assessing cumulative schemes as part of the EIA. However, the exact approach will be dependant upon the technical aspect, and will therefore be further defined as part of the assessment process. An example of this the Transport Assessment, which is likely to have a much greater spatial scope in terms of cumulative impact than the assessment for Ecology. The specific approach to assessing cumulatives for each technical aspect will be detailed within the technical chapters of the ES.

Alternatives Assessment

5.8 The EIA process provides an opportunity to consider alternative options with their respective environmental impacts. In accordance with the 2006 TWA Rules an outline of the main alternatives studied by the applicant will be provided together with an indication of the main reasons for his preference taking into account the environmental effects. The ES will describe those alternatives, which were considered by the applicant and design team, including:

- 'Do nothing alternative';
- Alternative transport solutions, for example road or bus service improvements, or a tram scheme; and
- 'Alternative NLE routes and designs' – the ES will summarise the evolution of the proposal, the consultation process behind the evolution, the modifications which have taken place to date and the environmental considerations which have led to those modifications that have determined the Reference Design, (i.e. the preferred route, preferred station arrangements and preferred vent shaft requirements). A

summary of the main alternatives considered will be presented together with a justification for the NLE Reference Design.

Description of Works

5.9 Chapter 5 of the ES (*Chapter 5: Site Preparation, Excavation & Construction*) will provide details on the proposed excavation and construction programme together with specific excavation and construction activities and methods and their anticipated duration.

5.10 Estimates of excavation volumes and the quantities of materials to be used throughout the construction programme will be considered and an estimate of the number of daily heavy goods vehicle movements (HGV) will be assessed in terms of traffic and so air quality and noise impacts.

5.11 The use of the River Thames (barge) for muck away operations will be also considered. Chapter 5 of the ES will provide details on the following:

- Indication of excavated spoil type and volumes (including indicative HGV, barge and rail movements);
- Indicative programme showing break down of muck away volumes on a seasonal basis;
- Highlighted areas of contamination and estimated volumes of contaminated material being excavated;
- Material split to show best estimated volumes of “mixed” spoil where segregation is unlikely to be possible; and
- Bulking.

5.12 In addition, an outline Community Consultation & Liaison Strategy and an outline Code of Construction Practice (CoCP) will be provided which will detail the specific mitigation measures to be followed to control the construction works and reduce nuisance incidents to a practicable minimum. TWUL, in their letter of 18/10/10, (reference no. 6VKF/AJ), noted that the CoCP should include a consideration of ground heave. The CoCP will address aspects specifically arising from:

- Construction traffic;
- Changes to access and the public rights of way;
- Operational hours;
- Road closures;
- Noise and vibration;
- Dust generation;
- Land contamination;
- Settlement;
- Ground heave;
- Ecology and nature conservation;
- Archaeology and built heritage;

- Waste resources;
- Energy use;
- Utilities diversion;
- Soil removal; and
- Waste generation.

Navigational Risk Assessment (NRA)

5.13 It is the responsibility of the PLA to ensure navigational safety along the Tidal Thames and promote the use of the River Thames for cargo handling and passenger transport, URS has engaged in a number of discussions with the PLA over the last three years to ascertain the requirement for a full muck away NRA for the main Battersea Power Station development, including the proposed NLE.

5.14 A meeting was held with the PLA (James Trimmer & David Foster) on 26 August 2008 to discuss the intended muck away operations and associated barge movements throughout the excavation and construction programme of main Battersea Power Station development, including the proposed NLE. Subsequently, a meeting was held on the 20th May 2010 with the PLA (Lucy Owen, James Trimmer and David Phillips) to update the PLA on the progress currently being made with the main Battersea Power Station planning application and to review the PLA’s formal comments made on planning application since its submission and registration by the LBW in October 2009. The requirement for a NRA was discussed with a commitment made (through a planning condition) to undertake this work in collaboration with the PLA at the appropriate point in the overall project programme.

5.15 Following further consultation with the PLA (email of 22/09/10), the PLA suggested alternative wording for paragraph 5.15 (which has been reworded) below and have requested that they are regularly consulted as to the projected barge operations associated with the NLE.

5.16 With regards to spoil excavation and muck away operations, it was concluded that it is not viable at this stage to assess fully the navigational risk of barge movements until the details of other expected major development and infrastructure projects which will use the River for cargo handling/muck away operations over the coming years (e.g. Crossrail, TWUL Tunnels and Lots Road) are better known. It was agreed with the PLA that we provide at the application stage, details of the volumes of excavation materials that will be generated over the course of the excavation and construction programme and the volumes to be removed by barge. In addition, the spoil type/make up (including volumes of 'mixed spoil' where segregation is unlikely to be possible) and volumes of excavated contaminated material will be estimated and how this will be handled/treated.

5.17 A Spoil Management Plan will be prepared to provide the details requested by the PLA above and the PLA will be regularly consulted on the projected barge operations.

5.18 The PLA has confirmed its willingness to assist with the identification of potential muck-away destinations, possibility in conjunction with other development/infrastructure projects. The PLA has also advised that it can facilitate the necessary negotiations with the owners/operators of the muck-away destinations with regards to types of materials, quantities and logistics.

5.19 In terms of the volumes of spoil anticipated to be generated through excavation of the NLE, the PLA has not expressed any concern about the capacity of the River Thames to accommodate the associated barge movements.

5.20 Prior to commencement of the excavation works and in consultation with the PLA (making use of its river traffic and navigational risk models) a full muck away NRA will be undertaken.

Policy Context

5.21 The assessment will have regard to all relevant National Planning Policy Statements (PPS), Planning Policy Guidance Notes (PPG), Regional Planning Policy Documents (including the London Plan and VNEB OAPF) and Local planning Policy Documents including the Unitary Development Plans and Local Development Frameworks of the LBW, the LBL and the LBS. Reference will also be made to the Mayors Transport Strategy. The planning policy review will be supported by Geographical Information System (GIS) mapping of key planning policy and environmental factors/considerations.

Transportation Assessment

5.22 The scope of the Transportation Assessment (TA) will form part of a separate scoping exercise currently being undertaken by Steer Davies Gleave. However, as the TA will be summarised within a chapter of the ES, the following provides a brief overview of the scope of the TA.

5.23 A full transport impact assessment and Transport Assessment (TA) will be prepared and submitted in support of the TWAO application. The transport impact assessment will consider the impact of the NLE on the local and strategic road network, particularly in relation to construction related vehicle movements and modal shift from road based modes of transport to the underground system, public transport capacity and pedestrian movements and key routes. The full TA will be summarised and impacts assessed within a chapter of the ES.

5.24 The LBS, in their letter dated 28/09/10 (reference no. 10-AP-2493), suggested that the ES should consider the routes followed by construction traffic and the consequent impact of that traffic; the impact of any temporary road closures necessary to facilitate construction; and the impact of the extension on operations and capacity of the Northern Line.

5.25 The Transportation Assessment will consider the following:

- The route followed by and consequent impact of construction traffic;
- The impact of any temporary road closures necessary to facilitate construction; and
- The impact of the extension on operations and capacity of the Northern Line.

5.26 It was noted by LUL (email dated 11/10/10) that no reference has been made to assessment of cumulatives in the transportation assessment. The PLA (dated 22/09/10) requested that the Transport Assessment should consider the impact of the NLE on the proposed piers at St. George's Wharf and Battersea Power Station. As part of the Transportation Assessment, cumulative impacts will be considered as discussed in section 5.2 (Methodology and Cumulative Impact Assessment) of this report.

Socio-Economics Assessment

5.27 In terms of Baseline Assessment, the Socio-Economics assessment presented within the ES will cover:

- The dynamics within the London economy;
- Employment in London's construction industry;

- The prominence of transport in the London economy;
- Transport-related health and physical fitness issues in London;
- The existing provision of open space facilities within accessible distances (as per the GLA Open Space Hierarchy) of directly impacted sites;
- A profile of existing demographic and health factors amongst the existing local population; and
- The expected demographics (population, age structure, marital status, ethnicity, health, housing tenure, employment characteristics) and travel patterns of the Battersea, Vauxhall, Nine Elms and Kennington areas.

5.28 In terms of Impact Assessment, the Socio-Economics assessment presented within the ES will cover:

- Employment generated during the construction phase;
- Employment generated during the operational phase;
- Wider socio-economic impacts derived from the role of the NLE in improving public transport accessibility, journey times and providing for enhanced access to jobs, education, health, community and retail/commercial facilities for existing and future local residents;
- Wider socio-economics impacts, as may be expected to result from the NLE in terms of its potential to act as an enabler and catalyst for further development in the Battersea/Nine Elms/Vauxhall area;
- Wider health impacts, such as impacts on physical fitness and other health impacts (including biological, lifestyle, social and community influences, physical environment and cultural conditions);
- Impact on accessibility and potential utilisation of local public open spaces during construction and operation;
- Impact on house prices and land values; and
- Assessment of the likely scale, permanence and significance of impacts.

5.29 Depending on the identity of the TWAO promoter, the ES may not be supported by a full Equality Impact Assessment or a Health Impact Assessment, as these stand alone documents are not required for the purposes of a TWAO Application. However, elements of the work usually presented within such documents will be captured within the ES.

5.30 The assessment will be carried out using a number of recognised data sources including, but not limited to the following:

- Office of National Statistics Labour Force and Neighbourhood Statistics;
- Annual Business Inquiry;
- Annual Population Survey;
- Census 2001;
- Annual Family Expenditure Survey;

- LBW published local area statistics, strategy, and policy; and
- Travel to Work data.

5.31 The assessment may also be informed, as appropriate, by studies undertaken as part of the project-related feasibility, transport planning and engineering design work, including but not limited to:

- VNEB Opportunity Area Transport Study Report, SKM, 2009;
- Northern Line Extension Options: Multi criteria Assessment of Route Options (draft NATA Assessment Report), SDG, 2010; and
- Other NLE-related WebTag and NATA assessment related studies and appraisals.

5.32 LUL recommends in their email dated 11/10/10, that the opinion of a recognised expert be sought when appraising the impacts of the socio-economic assessment.

5.33 Wherever possible the impacts of the socio-economic assessment will be appraised against relevant national standards such as those provided by HM Treasury, the DCLG and the Homes and Communities Agency. Where no standards exist, professional experience and judgement will be applied and the opinion of a recognised expert will be sought.

Electromagnetism Assessment

5.34 The Electromagnetism assessment will indentify potential electromagnetic hazards that may result from the proposed NLE. Hazards may include, but not be limited to, electromagnetic coupling risks between existing third party assets and infrastructure that may be installed as part of the project and threats to human safety from electromagnetic fields (EMF) that may be created by new infrastructure.

5.35 Conducted, radiated and mutually coupled electromagnetic coupling mechanisms will be considered between the new underground railway infrastructure and third parties outside the railway boundary.

5.36 Electromagnetic coupling risks will be calculated and assessed against defined maximum levels of threat for both electromagnetic compatibility and human health radiation hazards. The susceptibility criteria of neighbouring third parties will be determined based on in-house knowledge and those defined by regulatory requirements such as ICNIRP (International Commission on Non-Ionizing Radiation Protection) guidelines.

5.37 A standalone technical electromagnetic assessment report will be prepared and appended to the ES.

Archaeology and Heritage Resources

5.38 In terms of archaeological impact, only ground disturbance at or close to current ground level would result in an impact, whereas the running tunnels will be bored well below the level of anthropogenic strata and would not have an archaeological impact. Instead, all archaeological remains would be removed from any proposed intervention and ventilation shafts, TBM reception/intervention/ventilation shafts and station box footprints. There would potentially be additional impacts within temporary construction compounds/temporary grouting shafts.

5.39 The ES Archaeology Chapter will focus on ensuring that a clear and concise description is prepared of the archaeological resources of the above station, shaft and construction sites. This information will be used to assess the likely impact of the NLE works on potential archaeology.

5.40 Further to this the LBS recommend in their letter of 28/09/10, that consultation with the relevant archaeology officer for the area be undertaken, and that the desk based assessment should comply with the GLAAS guidance documents. The Greater London Sites and Monuments Record (GLSMR) and the London Archaeological Archive and Resource Centre (LAARC) will be consulted. The SMR is managed by EH and includes information from past investigations, local knowledge; find spots, documentary and cartographic sources, and Archaeological Priority Areas. LAARC includes a public archive of past investigations and is managed by the Museum of London. It often contains additional information and detail therefore complementing the GLSMR. In addition, the National Monuments Record (NMR) will be consulted for information on statutory archaeological designations, such as Scheduled Monuments.

5.41 The relevant archaeology officer for the areas where works are to undertaken will be consulted as part of the EIA process. It should be noted that a response has been sought and received from English Heritage who raised no objections to the proposed scope of the archaeological impact assessment.

5.42 The significance of the archaeological resources will be assessed in the context of the recently published Planning Policy Statement 5 (PPS5), which replaces PPG16 and PPG15. The archaeological assessment will include an assessment of the impact of the shaft and station structures on the archaeological resources of the site. The archaeology assessment will entail:

- Establishing both known baseline conditions and the potential for further discovery of archaeological remains around the shaft/station site from archaeological literature and standards published and documentary sources held by MOL Archaeology; the GLSMR; the National Monuments Record (NMR); and data held at the LAARC. A site visit will be carried out as part of the study. Any borehole and test pit logs obtained from geotechnical investigations carried out for solely engineering (non-archaeological) purposes will be examined and consideration given to sub-surface deposits and buried stratigraphy;
- An evaluation of archaeological resource importance (based on existing designations and professional judgement where such resources have no formal designation);
- Prediction of the magnitude of the likely works impacts upon known or potential archaeological resources;
- An outline of the mitigation measures required during the detailed design and excavation of the station and shaft sites in order to mitigate any adverse archaeological impacts; and
- Prediction of the significance of any residual impacts (impacts remaining after mitigation). The significance of residual impacts remaining will be assessed according to accepted criteria for assessing archaeological and historic sites.

5.43 An Archaeological Desk Based Assessment (DBA) will be prepared in addition to the ES Archaeology Chapter. The chapter will summarise the DBA and archaeological impacts and mitigation. The DBA will be appended to the ES.

5.44 The following guidelines and standards for archaeological work will be adhered to:

- Institute of Field Archaeologists – Code of Conduct;
- Institute of Field Archaeologists, 1994 Standard and Guidance for Archaeological Desk-based Assessments;
- English Heritage 1991 – Management of Archaeological Projects;

- Local Planning Authority (LBW, LBL and LBS) UDP and LDF; and
- Guidance presented within National and Regional Planning Policy documents for example PPS5.

Noise & Vibration

5.45 The proposed NLE route will pass under many areas that are potentially sensitive to noise and/or vibration. The majority of receptors are residential dwellings, commercial offices and retail outlets. The ES Noise & Vibration Assessment will focus on the following potential impacts:

- Airborne noise impacts associated with the construction and operational effects of temporary and permanent ventilation shafts;
- Vibration impacts associated with construction activities and the operation of the NLE;
- Groundborne noise associated with the operation of the proposed development; and
- Traffic noise during the construction and operation of the NLE.

5.46 The noise impact assessment will be undertaken in accordance with all relevant noise and vibration standards in the UK and will entail the following:

- Establishment of baseline conditions (2011 and likely Future Baselines);
- Derivation of applicable noise and vibration limits based on baseline conditions, this applies to both the construction and operational assessment;
- Derivation of relevant significance criteria in line with best practice;
- Review of construction activities and predictions of construction noise levels emanating from proposed worksites;
- Predicted noise impacts of vehicle movements to and from the proposed construction worksites;
- Prediction of noise and vibration associated with the operation of the proposed NLE (i.e. ground-borne noise and vibration and airborne noise associated with permanent ventilation and intervention shafts);
- Predicted noise impacts of vehicle movements to and from the NLE during operation and the potential change in traffic noise levels as a result;
- Prediction of significance associated with the above; and
- Outline of mitigation measures that will be required in order to mitigate any adverse impacts.

5.47 Noise monitoring will be undertaken at locations surrounding each potential shaft. These baseline noise measurements will facilitate the derivation of noise limits for the assessment of the potential construction and operational noise impacts from the shafts. Noise measurements will also be undertaken in the areas surrounding the proposed stations, receptors will include existing and proposed residential, leisure and business properties.

5.48 LUL, in their email of 11/10/10, recommend that key sensitive locations for vibration monitoring should be defined.

5.49 Detailed vibration measurements are not necessary at this stage as potential operational vibration levels from the NLE will be dealt with in terms of fixed limits. If any existing vibration is perceptible during site walkovers along the proposed NLE route then it will be prudent to undertake vibration measurements.

5.50 The LBW in their letter of 29/09/10 (reference no. DTS576849) noted that the scope for the noise and vibration assessment is satisfactory.

Air Quality

5.51 The Air Quality Strategy for England, Scotland, Wales and Northern Ireland provides the over-arching strategic framework for air quality management in the UK and contains national air quality objectives established by the Government to protect human health; these objectives apply to outdoor locations where people are regularly present and do not apply to occupational, indoor, or in-vehicle exposure.

5.52 The entire borough of Wandsworth is designated as an Air Quality Management Area (AQMA) due to current or predicted exceedances of these objectives for nitrogen dioxide (NO_2) and fine particulate matter (PM_{10}). Similarly the northern part of Lambeth, which includes part of the study area, is also designated an AQMA due to NO_2 concentrations. This AQMA extends as far south as Kennington Park and includes a number of roads and fronting properties in Tulse Hill, the A202 Camberwell New Road, A3036 Wandsworth Road, A203 South Lambeth Road, A3, A2217 Clapham Park Road, and the A23. The LBS identified in their letter of 28/09/10 (reference no. 10-AP-2493) that the Southwark AQMA extends to the entirety of the borough north of the South Circular Road A205. The third borough that NLE includes is Southwark, which has designated an AQMA encompassing entire northern part of the borough for NO_2 and PM_{10}, which will include part of the study area (extending from Rotherhithe to Walworth and Camberwell and up to the boundary on the River Thames. The area is the entirety of the borough north of the South Circular Road A205.

5.53 Within the Nine Elms, Battersea and Kennington area, the following land uses are considered potentially sensitive to changes in local air quality:

- High Sensitivity: Residential dwellings, care homes, and hospitals, due to the potential for people to be present at these locations 24 hours a day and potentially housing the most sensitive members of public to air pollution (e.g. the elderly or ill);
- Medium Sensitivity: Churches, open spaces, parks and gardens, hotels, libraries, community centres, and educational facilities. These are locations where sensitive members of the population might typically be present for only a few hours; and
- Low Sensitivity: Areas of commercial/offices and light industry (workplace limits are used instead).

5.54 It is anticipated that emissions to air will occur during site construction activities due to:

- The operation of construction vehicles and site plant;
- Movement of road traffic, predominantly HGVs; and
- Earth moving activities (i.e. construction dust).

5.55 Operational emissions will be associated with:

- A change in modal shift, resulting in net changes to vehicle movements on local roads. This is expected to be predominantly positive, with the NLE expected to reduce dependence on road vehicles;
- Short term exposure to potentially poor air quality in the Underground Stations and platforms;
- The discharge of 'dusty' air from stations and platforms through a number of ventilation shafts that will be positioned along the route; and
- Indirect emissions associated with offsite electricity generation at a nearby centralised power substations.

5.56 Background existing air quality will be determined using data from nearby automatic monitoring stations, supplemented by Local Authority diffusion tube data and the LAQM.TG(09) background maps. 'Newton Preparatory School' roadside diffusion tube station (on the southern side of Battersea Park Road) and 'Lambeth 2 - Vauxhall Cross' automatic roadside station (on the traffic island in the middle of Bondway/Wandsworth Road / Parry Street) will be used to verify the modelled, along with any additional diffusion tube data in Lambeth and Southwark. It is not proposed to conduct any additional monitoring in the study area given the good availability of the aforementioned data and inherent ±20% level of uncertainty associated with diffusion tube monitoring. The impact to roadside emissions is also expected to be an overriding positive effect; therefore, arguably requiring less detailed verification of the model output.

5.57 The effect of road traffic emissions during construction will be assessed using the DMRB screening tool, for roads where there is a change in daily road traffic flows of greater than 5%. The detailed model ADMS4.2 will be used to screen the effect of construction dust and site plant emissions on local receptors. The likely intensity of impact will be considered along with the approximate number of receptors within a given distance from the activity and sensitivity of these receptors.

5.58 Following determination of these impacts, a suite of mitigation measures will be recommended for the control of dust and site plant emissions during construction works, with specific attention paid to the Local Authorities' Code of Construction Practice and the Major of London's guidance on The Control of Dust and Emissions from Construction and Demolition. Additional Site-specific mitigation measures will be proposed as necessary, in order to minimise or remove adverse impacts to local air quality.

5.59 Operational emissions associated with the modal shift will be assessed using the ADMS-Roads dispersion model, with regional emissions (tonnes per year (t/yr)) calculated using the DMRB screening tool. The modelling will focus upon NO_2 and PM_{10}, which are the two main pollutants of concern in London. A number of traffic scenarios will be modelled, including present-day (2011 Baseline), a Future Baseline without the NLE and a future date (year of opening of the NLE) with the NLE. Changes in concentrations will be calculated along each study road and 2001 Census population data extracted from GIS to estimate the number of people living within each band of pollutant change. The DMRB 'WebTag' methodology will be subsequently applied in order to calculate the net change across the study area due to the modal shift (i.e. whether the overall change can be considered to be positive or negative).

5.60 The exposure of public to poor air quality in platforms and stations will be assessed using recent London Underground sampling data and reports, to determine likely concentrations of dust and PM10 at these locations. LUL in their email of 11/10/10, questioned the applicability of using LUL sampling data on air quality at a station level, and suggested that further discussion with the LUL environmental team would be required. As such, further discussions will be undertaken with LUL as to the applicability of using LUL sampling data for air quality at station level.

5.61 The emissions from ventilation shafts would be based on 1 day's sampling undertaken at Bond Street Station on the Jubilee Line as part of the Crossrail Environmental Impact Assessment, with the discharge screened using the detailed model ADMS 4.2 to predict the likely impact at nearby receptors (should sufficient design parameters exist to accurately model emissions). The LBS, in their letter 29/09/10 (reference number 10-AP-2493) raised the need for monitoring results to ascertain the degree of discharge from the ventilation shafts in the borough.

5.62 As part of the assessment, a report on vent emissions on the Jubilee Line, prepared for Crossrail, will be used to ascertain the degree of discharge from LUL vent shafts. This will be used to provide baseline data to assess the impact of the vent shafts on air quality.

5.63 An indirect impact of the project will be the offsite electricity generation, which has the potential to lead to significant releases of pollutants and CO_2. It is likely that the power station providing the electricity falls under the Environmental Permitting regulations (due to it more than a 20 megawatt capacity) and would therefore have already completed a dispersion modelling exercise as part of this process. This report will be reviewed and the incremental change due to the Northern Line Extension estimated. Should the power station supplying the electricity not be known or agreed at the time of reporting; however, then the power demand would be estimated and likely impact discussed qualitatively.

5.64 An inventory of atmospheric emissions will be reported for both the construction and operational phases of the development, calculating the total tonnes/annum of NO_X, PM_{10} and CO_2, based on industry accepted emission factors such as the Design Manual for Roads and Bridges (DMRB), EMP/CORINAIR, and United States Environmental Protection Agency. The anticipated payback time for the project would also be calculated (i.e. the number of years taken for emissions to 'break even' following construction assuming that the modal shift more than offsets the emissions from power generation).

5.65 In response to the LBS, in their letter 29/09/10, the reporting of the atmospheric emissions inventory will take into account the London Atmospheric Emissions Inventory produced for the GLA by AEA Group.

5.66 The assessment will determine the whether the baseline air quality currently exceeds the National Air Quality Strategy objectives (and well as for the future baseline year), as well as the severity, extent, and duration of predicted impacts to local air quality at sensitive receptors in the locality.

5.67 The assessment of potential impacts and their significance will be based on the criteria outlined in the Environmental Protection UK (formerly National Society for Clean Air) publication 'Development Control: Planning for Air Quality', which will take into account both the magnitude of the change caused by the NLE and the absolute concentrations in relation to the air quality objective. Particular significance will be given to a change that takes the concentration from below to above the objective or vice versa because of the importance ascribed to the objectives in assessing local air quality, as set out in Planning Policy Statement 23. The descriptors also allow for a very small change in concentration being more significant when the concentration is above the objective than when it was below the objective.

5.68 The LBW, in their letter dated 29/09/10, noted that the scope is satisfactory.

Ecology

5.69 The ecological impact assessment and Ecology ES Chapter will detail the Assessment Methodology and Impact Significance Criteria used in the assessment of potentially significant ecology effects. The assessment method uses a process of assigning values to the identified ecological features and resources, predicting and characterising the magnitude of ecological impacts and, through this process, determining the significance of potential impacts on ecological receptors (post mitigation).

5.70 In order to understand the nature of all biodiversity attributes present at the above ground sites (stations, shafts and grouting sites), a Phase 1 Habitat survey will be undertaken in accordance with the Joint Nature Conservation Committee guidelines. This will comprise an Extended Phase 1 Habitat Survey whereby the actual presence of, or potential for, protected species of flora and fauna are recorded. Should the need for any further ecology survey work be identified to facilitate a full understanding of the status and sensitivity of protected and/or notable habitats, species or assemblages, these will be undertaken in additional surveys in the appropriate time of year/survey periods.

5.71 Consultation will be undertaken with the local biological records centre Greenspace Information Service for Greater London (GiGL). Further consultation may be required with specialist groups such as the London Bat Group in order to obtain a full suite of data on the biodiversity found at and the near the sites in question. In addition, a number of on-line resources will be used to obtain data on protected species. LUL suggested in their email of 11/10/10, that information is obtained from the LU GIS systems to supplement the ecology assessment.

5.72 Sources of contextual information that will be used will include:

- Multi-Agency Geographic Information for the Countryside (MAGIC);
- Natural England's Natural Area profiles;
- Natural England's Nature on the Map;
- Joint Nature Conservation Committee (JNCC);
- National Biodiversity Network (NBN) Gateway;
- London Wildweb;
- United Kingdom Biodiversity Action Plan (BAP);
- LUL GIS database;
- London BAP; and
- London Underground BAP.

Water Resources, Drainage & Flood Risk Assessment

5.73 In order to satisfactorily assess the potential impact of flood risk (and any mitigation measures arising from the assessment) a formal Flood Risk Assessment will be undertaken and will be carried out in accordance with Planning Policy Statement 25 – Development and flood Risk (PPS25), recently updated in March 2010.

5.74 A preliminary consultation meeting was held on 13th April 2010 between the Environment Agency (EA), URS and Buro Happold. The EA has confirmed that they would expect to see a formal FRA prepared and included as part of the ES for the TWAO application. The EA also clarified that the scope of the FRA should include consideration of potential flood risk and mitigation from the Thames (including breach scenarios to be defined by the EA), from surface water, and from ground water.

5.75 The FRA will consider the impacts of flood risk on the NLE development, and impacts of the NLE development on flood risk to 3rd party interests. The main issue will be an assessment of the implications of a failure of the flood defences during an extreme tidal event. This is referred to as a breach assessment, and involves the hydraulic modelling of the depths, speed and duration of flooding that would result from a breach. The results of the modelling (both the baseline and with the NLE development in place) will identify

potential impacts, and from this, the mitigation that may be necessary to deal with these impacts will be defined. In addition, the FRA will consider the implications for surface water flooding (and drainage provision) as well as flood risk from groundwater.

5.76 In flood risk vulnerability terms, the proposed underground extension would be classified as "Essential Infrastructure", and will have to pass the Exception Test as set out in PPS25. The EA has indicated (in our preliminary meeting) that the Sequential Test would not apply in this case. The NLE will be designed and constructed to remain safe and operational for users in times of flood, including a breach scenario as described above.

5.77 It is evident from all the flood risk assessment work undertaken for the main Battersea Power Station application that both a station on the Power Station site and the station within the Nine Elms area will lie within the defended floodplain of the Thames, and that the Nine Elms area lies within the potential flood extent resulting from a breach in the tidal defences. The vulnerability of a site to a breach depends to a great extent on the location chosen for the breach. In the case of the main Battersea Power Station planning application, breach locations for modelling that were considered to give rise to the worst flood risk were agreed with the EA. These locations are now under review by the EA, and the EA will confirm the locations required for breach analyses that are specifically relevant to the NLE. The EA requested in their letter of 11/10/10 (reference no. SL/2010/107333/01-201) that the FRA should be appended to the ES.

5.78 The FRA will incorporate:

- Liaison and ongoing consultation with the EA to agree the scope and monitor progress of the FRA;
- Liaison and integration of the ongoing assessment with the wider ES process;
- Breach analyses (number to be confirmed by the EA) of the existing river wall flood defences, including flood velocity and the rate of onset of flooding;
- Assessment of flood probability and flood depth;
- Support and guidance to the Design Team on the emerging flood risk, through the design development process to RIBA Stage D;
- Inclusion of appropriate allowances for climate change for the life of the development;
- Assessment of risks due to surface water flooding;
- Assessment of risks due to flooding from groundwater;
- Flood risk mitigation measures to ensure a safe development;
- Assessment and reporting of residual flood risks;
- Incorporation of the surface water management strategy proposed for each Station location; and
- Preparation of the formal FRA as an annex to the ES.

5.79 TWUL, in their letter dated 18/10/10 (reference no. 6VKF/AJ) has requested that the following be considered:

- Battersea groundwater abstraction point which is very close to the route at the western end of the proposed alignment;

- The potential impact of the NLE on groundwater;
- All relevant TWUL assets should be identified; and
- Impacts on the TWUL Tideway Project.

5.80 TWUL also requested that cross sections of the NLE should be included in the scoping report.

5.81 The assessment will identify and assess groundwater abstraction points within the scope of the NLE. As part of the Water Resources, Drainage and Flood Risk Assessment the impact of the NLE on groundwater will be assessed. TWUL assets will be identified during a services search and be included as part of the baseline study. The ES will assess the impact of the NLE on the Thames Tideway Project.

5.82 Cross sections showing provisional elevations of the scheme are included in Appendix B.

Ground Conditions & Settlement

5.83 For each construction/shaft and station site (both permanent and temporary), the EIA will confirm the site's contaminative status through a desktop study of potential soil contamination with respect to the new regime for contaminated land set out in Part IIA of the Environmental Protection Act (1990). The desktop study will refer to a site-specific Envirocheck Report and will take account of historical and existing operations/services within the site boundary in order to assess the potential for contaminative activities to have taken place on the site. Reference will be made to previous desktop assessments and the March 2010 intrusive investigations (for the characterisation of the geotechnical and hydrogeological properties of the area where the NLE route passes).

5.84 The ES will include a Conceptual Site Model (CSM) and risk assessment for each construction/shaft and station site. Where relevant, measures for the clean up (remediation) of any contaminated land encountered during the excavation and construction phase will be identified within the ES. Similarly, mitigation measures will be employed to eliminate the risk of mobilising contaminants during excavation and construction.

5.85 The EA, in their letter dated 11/10/10 (reference no. SL/2010/107333/01/L01) suggested that the ES should incorporate issues related to dewatering of contaminated water and discharge during construction.

5.86 The ES will assess potential impacts relating to dewatering of contaminated water and discharge during construction. The application of standard mitigation measures during the excavation and construction phase should ensure protection of groundwater and the drainage system. However, the ES will verify any potential impacts to drainage and groundwater resources from the excavation, construction and operational phases of the NLE.

5.87 During the reference design phase settlement predictions shall be carried out to identify all buildings and utilities that lie within the 1mm zone of ground movement resulting from the proposed works. For buildings and utilities which lie within the 10 millimetres (mm) zone of ground movement or have a predicted ground slope of 1:500, an initial assessment of predicted damage shall also be undertaken. On completion of the predicted damage assessment, methods of construction shall then be designed to ensure that damage to buildings does not exceed Degree of Damage 2 (Slight) as defined by Burland *et al* (1977). The assessment and mitigation of damage to utilities shall be made in consultation with the relevant utility providers. Impacts associated with settlement and any required mitigation will be outlined within the ES.

5.88 The LBW noted in their letter dated 29/09/10 (reference no. DTS576849) that the scope is satisfactory.

Townscape, Built Heritage and Visual Impact – ES Volume II

5.89 Volume II of the ES will include an assessment of the NLE in relation to its local and wider setting by considering a number of pre-agreed views, architectural and historic accounts of the area and policy designations - such as conservation areas and listed buildings.

5.90 The Tavernor Consultancy will specifically address the location of the proposed ventilation/intervention and grouting shafts and the stations and will assess potential townscape and visual impacts of all the above-ground structures.

5.91 Visual representations of the above ground structures (shaft head buildings and stations) will be inserted into the selected views to demonstrate potential impacts on the townscape. Specifically, the methodology will cover:

- Rationale for the selection of views and ways in which the NLE's above ground structures are represented within them;
- Explanation of the guidance and criteria used to assess the views; and
- Means of photographing and verifying views and validation of photomontage methods. The level of detail presented within the photomontages will be agreed with the LBW, the LBL and the LBS.

5.92 The views impact assessment will be informed by:

- A desk-based survey of the architectural quality and history of the buildings presently on the shaft sites and in the vicinity of the sites in question;
- Site visits and archival research of historic plans, photographs and maps;
- An appraisal of locally and statutorily listed buildings, conservation areas, world heritage sites, ancient monuments and registered parks of historic interest potentially affected by the design proposals;
- Relevant local, regional and national planning policy and design guidance in relation to historic environments and views management;
- Guidelines issued by relevant authorities on means of assessing townscape qualities and visual impacts; and
- Consultation with the LBW, the LBL and the LBS in addition to other advisory bodies such as EH and the Garden History Society.

5.93 The views impact assessment will include:

- An overview of the methodology of the assessment, including the rationale for the view selection and representation of the design proposals; explanation of the criteria and guidance for appraisal of the townscape and assessment of the designs;
- A written appraisal of the architectural character and historic evolution of the existing townscape of the shaft sites and the surrounding areas;
- An appraisal of the proposed designs of the head buildings and how they relate to their townscape settings; and

- An assessment of each above-ground structure in relation to its local setting by considering 1 to 2 pre-selected views per site, architectural and historic accounts of the townscape, heritage assets nearby, relevant policy designations and consented schemes in the vicinity that will alter the townscape in the future.

6. NON-SIGNIFICANT ENVIRONMENTAL ISSUES

6.1 The aim of the Scoping Phase is to focus the EIA on those environmental aspects that may be significantly impacted by the works. The significance of impacts associated with each environmental aspect can then become more clearly defined, resulting in certain aspects being considered 'non-significant'.

6.2 Given the sensitivity of the area and the scale of works proposed no 'non-significant' environmental issues have been identified thus far. As such, all of the aspects discussed above are considered as potentially significant until further detailed work on the EIA is undertaken.

7. PROPOSED STRUCTURE OF THE ENVIRONMENTAL STATEMENT

7.1 The ES will comprise the following set of documents.

7.2 *Non-Technical Summary (NTS):* this document will provide a summary of the key issues and findings of the EIA. The NTS will be presented in non-technical language to assist the reader to understand the context of the NLE, the Reference Design, the alternatives considered; the environmental issues arising and proposed mitigation measures.

7.3 *Volume I: Environmental Statement*. This will contain the full text of the EIA with the proposed chapter headings as follows:

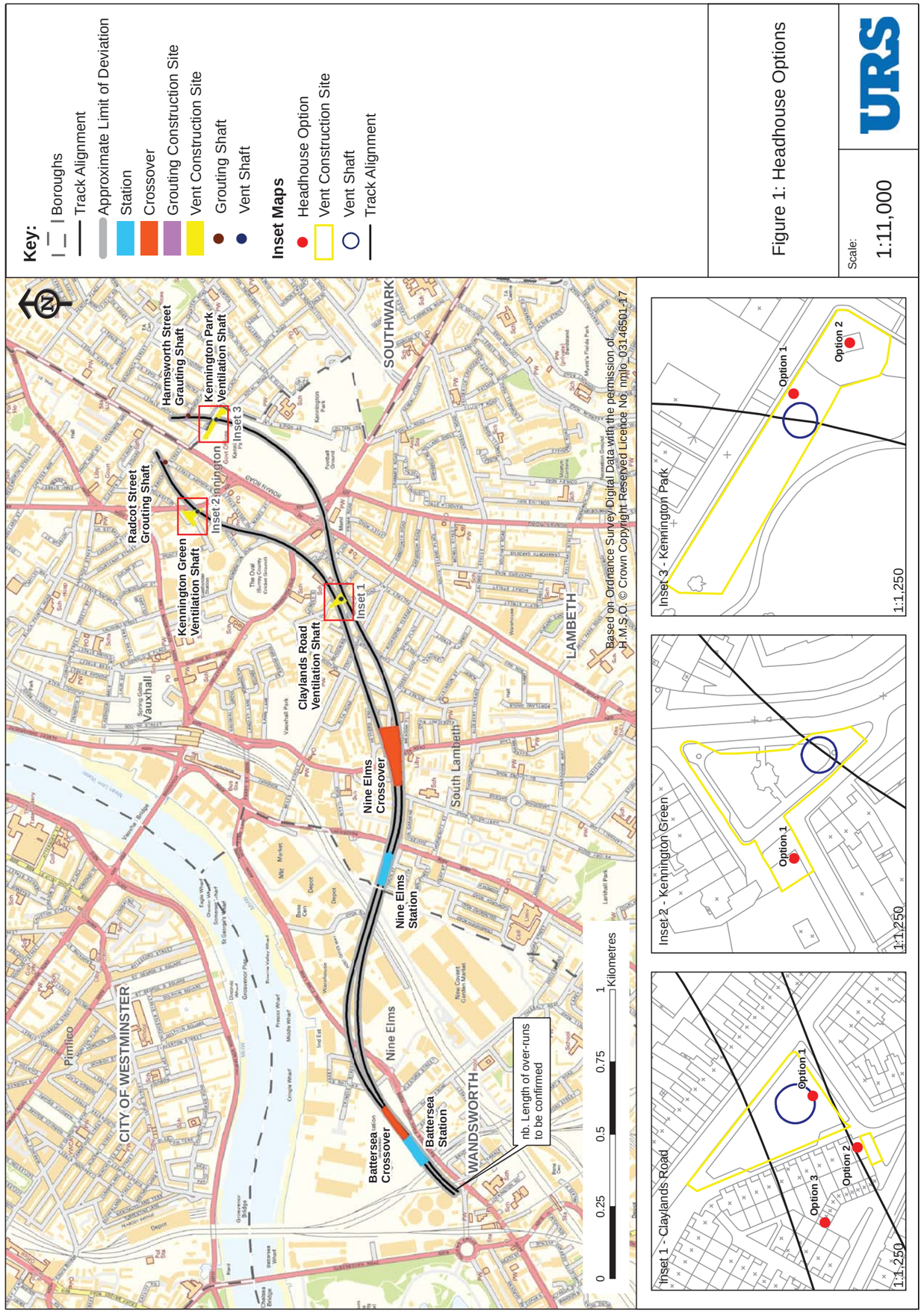
- Introduction;
- EIA Methodology;
- Options and Alternatives;
- Description of Works;
- Planning Policy Context;
- Transportation and Access;
- Socio-Economics;
- Archaeology and Heritage Resources;
- Noise & Vibration;
- Air Quality;
- Electromagnetism;
- Ecology;
- Water Resources, Drainage & Flood Risk;
- Ground Conditions & Settlement;
- Cumulative Impact Assessment; and
- Residual Impact Assessment and Conclusions

7.4 *Volume II: Townscape, Built Heritage and Visual Impact Assessment*: the ES will include a stand-alone Townscape, Built Heritage and Visual Impact Assessment accompanied by a set of views and verified images.

7.5 *Technical Appendices*: these will provide supplementary details of the environmental studies conducted during the EIA including relevant data tables, figures and photographs.

Figure 1:

Route Option 2



Appendix A.1:

Port of London Authority Email

Dated: 22/09/10

"Owen, Lucy" [redacted]
22/09/2010 14:12

To [redacted]
cc
bcc
Subject Battersea Power Station - NLE EIA Scoping Report

History: This message has been forwarded.

Juliette,

I received a letter from Tony Whitehead of Treasury Holdings dated 20 August 2010 enclosing a copy of the Scoping Report for the Northern Line Extension. The letter provides your contact details and as we have now reviewed the document but have not yet been formally consulted by the Local Planning Authority I thought you might like our comments direct.

The Harbour Master has made comments on paragraph 5.12 and has recommended alternative wording which I have set out below (or something along the lines of this):

"With regards to spoil excavation and muck away operations, it was concluded that it is not viable at this stage to assess fully the navigational risk of barge movements until the details of other expected major development and infrastructure projects which will use the River for cargo handling/muck away operations over the coming years (e.g. Crossrail, Thames Water Tunnels and Lots Road) are better known. Rather, it was agreed with the PLA that we provide at the application stage, details of the volumes of excavation materials that will be generated over the course of the excavation and construction programme and the volumes to be removed by barge. In addition, the spoil type/make up (including volumes of 'mixed spoil' where segregation is unlikely to be possible) and volumes of excavated contaminated material will be estimated and how this will be handled/treated. In the meantime, if the PLA are kept informed they will be able to reflect better the needs of the Battersea Power Station project in their dealing with other projects to ensure that barge operations are viable. Nevertheless, on the information presented to the PLA to date it is not expected that there will be any serous navigational risk that could prevent barge operations.

Additionally, given the proposed passenger piers at Battersea Power Station and at St George Wharf it would be useful if the transport section of the ES considered how the NLE would impact on these piers.

Regards
Lucy

Lucy Owen
Planning Officer
Port of London Authority

London River House, Royal Pier Road
Gravesend, Kent, DA12 2BG

[redacted]

www.pla.co.uk

website: www.pla.co.uk
****
****

Appendix A.2:

English Heritage Letter

Dated: 29/10/10

Ref. No.: LAG/22/468-1

ENGLISH HERITAGE

Head of Planning
Development Control
Phoenix House
10 Wandsworth Road
London
SW8 2LL

Your Ref: -

Our Ref: LAG/22/468-1
LAG/32/504
Contact: Mark Stevenson

Direct Dial: 020-79733737

29 October 2010

Dear Sir/Madam,

TOWN & COUNTRY PLANNING ACT 1990
PLANNING POLICY STATEMENT 5

Northern Line Extension: pre-application Scoping Opinion
Northern Line extension (Transport and Works Act 1992); observation on the EIA Scoping Report for route options from Kennington to Vauxhall/Nine Elms and Battersea.

Recommend Approval of Archaeological Report

I am grateful to Mr Whitehead of Treasury Holdings for his email dated 12 October 2010 with attached scoping report dated August 2010 in addition to a hard copy posted same day.

Having considered the submitted document I am happy to recommend its approval. I wish to point out the reference to PPG16 should be replaced by PPS5 and 'Institute of Field Archaeologists' should read 'Institute for Archaeologists'. Both points do not affect the recommendations stated within the scoping document. I look forward to receiving copies of the first batch of desk-based assessments for the archaeology and built heritage for comment in the near future.

If you need any further information at this stage please contact me and please note that this response relates solely to archaeological considerations.

Yours sincerely

Mark Stevenson
Archaeology Adviser
London Region
Cc Mr T Whitehead, Treasury Holdings,
Battersea Power Station, 188 Kirtling Street, Battersea, London, SW8 5BN

1 WATERHOUSE SQUARE, 138 – 142 HOLBORN, LONDON, EC1N 2ST

Telephone 020 7973 3000 Facsimile 020 7973 3001
www.english-heritage.org.uk

Appendix A.3:

London Underground Limited Email

Dated: 11/10/10

From: Keelan Glenn [redacted]
Sent: 11 October 2010 14:52
To: Tony Whitehead
Cc: Kirkup Jon; Holmes Thomas; peter_miller[redacted]; 'Noak, Martyn'; 'McCann, David'; DCSFA; Povey Deryck
Subject: NLE - EIA Scoping Report

Tony,

Thanks for your letter 20/08/10 and attached document titled above. I've responded ion e-mail format for expediency but will happily transfer into a separate document / standard comments format. I've obtained limited but appropriate input through internal consultation (did not pursue a business-wide review, rather focussed on key personnel with specific experience of TWAO / ES) and would offer comments as follows.

- Para 1.1 – Given that this document follows the 'decision' on Route 2 Alignment should it be saying "depending on final route selection"? Accept there may be a timing/overlap issue but the final version should be clear on contents of scheme.
- Para 1.9 – Development densities; were these the "GLA's desired...densities in the VNEB OA"? Thought the BPS site densities were set by THUK?
- Para 1.10 – see 1.1.
- Para 2.1 – As with 1.1, I'd suggest that the scoping either includes or excludes an intermediate station.
- Para 2.4 – Tph figure; needs to be addressed with Sponsor for next version of document.
- Para 4.2 – Consultation; It should be assumed that there will be consultation with City Of Westminster. We understand that WCC feel they should be consulted (even though they are the other side of the river) and they are likely to be affected by some of the 'cumulative effects'. It would be helpful to define what is meant by "Local residents and owners and occupiers of the adjacent properties including surrounding landowners, businesses and developers". In particular does this refer only to those close to the surface interventions or does it include those along the route (who may be affected by settlement) as well? Also, it may be prudent to specifically identify the Office of the Rail Regulator (ORR); if THUK are sole promoter on this scheme then they cannot rely on LU's Safety Case and self-regulation.
- Section 5.0 Onwards – the numbering system falls apart in this section – Para 5.2 followed by section 5.2, etc.
- Para 5.17 - Transport Impact Assessment; no reference to cumulative impact. See also comment on 4.2
- Para 5.20 – We note it says "the ES may not be supported by a full Equality Impact Assessment or a Health Impact Assessment, as these stand alone documents are not required for the purposes of a TWAO Application. However, elements of the work usually presented within these such documents will be captured within the ES." There now seems to be a growing expectation that an HIA should be provided and it may actually be simpler to do a full HIA (and get separate sign off) rather than try and cover the issues in the ES. Likewise it would be worth exploring the 'expectations' of the key consultees on the need for an Equality IA; one of the aspects of this is usually equality in employment opportunities which you refer to in Para 5.18.
- Para 5.23 – Socio-economic/standards; perhaps refer to 'opinion of a recognised expert will be sought'?
- Para 5.29 – Archaeology; MOLAS view could differ substantially. Depending on site location, boreholes can be proposed to survey 'strata' for geo-archaeology, e.g.,

changing land use over time. Happened at VSU.

- Para 5.38 – Background monitoring; which “key sensitive locations”?
- Para 5.43 - Air quality; what is anticipated by:
  - Short term exposure to potentially poor air quality in Underground Stations and platforms;
  - The discharge of ‘dusty’ air from stations and platforms through a number of ventilation shafts that will be positioned along the route;

By inclusion in this document you are stipulating that these are ‘negative’ and potentially significant?

- Para 5.48 – “recent ...London Underground sampling data...” I’d suggest we discuss the applicability with our environmental team. We’ve already responded to Halcrow on this subject.
- Para 5.55 – LU also has a GIS which could be referenced.
- Para 5.68 – should listed buildings get special consideration as regards potential settlement effects?

Happy to discuss any of the above once you’ve had the opportunity to digest.

Regards

Glenn

Senior Project Manager
London Underground Ltd.,
Capital Programmes Directorate
Stations and Accommodation
5th Floor Victoria Station House
191 Victoria Street
London SW1E 5NE
[redacted]

Appendix A.4:

Natural England Letter

Dated: 09/10/10

Ref. No.: B05/2-10/32-1

Date: 9 September 2010
Our ref: B05/2-10/32-1
Your ref:

Mr Tony Whitehead
Treasury Holdings
Battersea Power Station
188 Kirtling Street
London
SW8 5BN

Natural England
Zone E7
6th Floor
123 Ashdown House
London
SW1E 6DE

T 0300 060 1373
F 020 7932 2201

Dear Mr Whitehead,

Northern Line Extension: The Transport and Works (Applications and Objections Procedure) (England and Wales) Rules 2006 – Environmental Impact Assessment Scope

Thank you for your letter and enclosures dated 20 August 2010, requesting Natural England's views and comments on the above planning application.

Natural England is the Government agency that works to conserve and enhance biodiversity and landscapes, promote access to the natural environment, and contribute to the way natural resources are managed so that they can be enjoyed now and by future generations.

After careful consideration of the information provided it is our opinion that the proposed Scoping report covers the areas and issues that Natural England would wish to considered in such a document. The approach and methodology are appropriate and in line with advice that would be offered by Natural England. Natural England also welcomes the opportunity to discuss and comment on this proposal as the scheme develops.

I trust that this is sufficient for your purposes, and makes Natural England's position clear but if you have any further questions about this letter or require further information please do not hesitate to contact me.

Yours Sincerely,

David Hammond
Planning and Advocacy Adviser
Natural England London Region

[redacted]

Natural England
Head Office
1 East Parade
Sheffield S1 2ET

www.naturalengland.org.uk

Appendix A.5:

London Borough of Wandsworth Letter

Dated: 29/09/10

Ref. No.: DTS576849

Wandsworth Council
Technical Services Department
The Town Hall
Wandsworth High Street
London SW18 2PU

Please contact: Mark Hunter
Telephone: (020) 8871 8413
Fax: (020) 8871 6003
Email: boroughplanner@wandsworth.gov.uk
Web: www.wandsworth.gov.uk
Minicom: (020) 8871 8403

Treasury Holdings
Fao Tony Whitehead
Battersea Power Station
188 Kirtling Street
London
SW8 5BN

Our ref: DTS576849
Your ref:
Date: 29th September 2010

Dear Sir,

Northern Line Extension: The Transport and Works Act (Applications and Objections Procedure) (England and Wales) Rules 2006
Environmental Impact Assessment Scope.

I refer to your letter of 20th August 2010 and accompanying Scoping Report, addressed to Bob Leuty, who has asked me to respond on his behalf.

The Council has considered the EIA Scoping Report outlining the information to be provided in the Environmental Statement to be submitted to accompany the Transport and Works Act Order, in respect of the proposed Northern Line underground railway extension from Kennington to Battersea Power Station and would make the following comments.

I trust that you are fully cognisant of the planning policy context, and do not feel there would be anything to gain by repeating it here. However, please contact me further if you would like clarification on any particular points.

You point out that you have undertaken your own consultation, listing the consultees to which you have sent a copy of the Scoping Report. Given this, I have only consulted internal contacts within the Council who are considered have comments to make.

Your scoping generally covers the matters that need to be addressed in the Environmental Statement, and on the basis of the documents you have provided and the consultation responses received to date, I have the following comments to make.

Noise and Vibration

The scoping report regarding the monitoring of noise and vibration during construction and after the works is satisfactory.

Air Quality

The Scoping Report contains full proposals for the assessment of air quality impacts potentially arising from this development.

Ecology

The list of sites which will require ecological consideration is more extensive than that listed in para. 3.6, although this can be addressed through the consultation with Greenspace Information for Greater London as suggested in para. 4.1.

Flooding Issues

The Council has been contacted separately on flooding issues. This has been answered separately, but I copy the information here for the sake of clarity.

The Council holds limited information on surface water flooding. The Strategic Flood Risk Assessment contains a list of surface water flooding 'hotspots' and 'areas with and increased risk of surface water ponding based on topography, geology and historic flooding records.' Figure 9A shows this information and can be downloaded from our website along with the rest of the SFRA (see link):
http://www.wandsworth.gov.uk/downloads/495/planning-environmental_policies

Further work to obtain a comprehensive list of surface water flooding data is in progress through the 'Drain London Project which is being led by the Greater London Authority' however results of this will not be available until April 2011. Further detailed information can be obtained from the Environment Agency and Thames Water.

The Council holds no information on groundwater levels in the vicinity of the site. The Environment Agency may have specific details.

Policy PL2 of the Core Strategy and Policy DMS 6 of the Development Management Policies Document are relevant policies regarding Flood Risk management. DMS6 will not be considered a planning material consideration until the 29th of October once the start of the consultation period begins on the proposed submission version. Both policies are a result of detailed discussions and agreements with the EA and therefore DMS6 is likely to be what the EA would expect regardless of the policy status of DMS6.

Policy PL2 of the Core Strategy can be viewed via the following link:
http://www.wandsworth.gov.uk/downloads/file/3307/core_strategy-pre-adoption_version_incorporating_inspectors_changes

Policy DMS6 of the DMPD can be viewed via the following link:
http://www.wandsworth.gov.uk/moderngov/Published/C00000503/M00003485/AI00018257/10695DevelopmentManagementPoliciesDocument.pdf

The Council holds no information regarding constraints on surface water discharge to sewer. The Environment Agency would normally advise on these matters. I note you have consulted the separately.

The Council holds no information regarding private water supplies in the vicinity of the site. Thames Water/EA may have specific details.

Ground Conditions

The report indicates that appropriate steps would be undertaken for the assessment of land contamination, and if necessary the remediation of land contamination

The Council would stress the mitigation potential of environmental impacts should be a theme permeating all areas of the environmental statement as should impact on future development sites. Should I receive any further comments in respect of the report I will write to you again to make you aware of these comments.

Yours sincerely

Mark Hunter
Principal Planner
Vauxhall/Nine Elms/Battersea Opportunity Area
For Borough Planner

Appendix A.6:

Environment Agency Letter

Dated: 11/10/10

Ref. No.: SL/2010/107333/01-L1

creating a better place

Environment Agency

Mr Tony Whitehead
Treasury Holdings UK Ltd
Battersea Power Station
188 Kirtling Street
London
SW8 5BN

Our ref: SL/2010/107333/01-L01
Your ref:

Date: 11 October 2010

Dear Mr Whitehead

NORTHERN LINE EXTENSION

THE TRANSPORT AND WORKS (APPLICATIONS AND OBJECTIONS PROCEDURE) (ENGLAND AND WALES) RULES 006 - ENVIRONMENTAL IMPACT ASSESSMENT SCOPE

Thank you for consulting the Environment Agency on the EIA Scoping Report dated August 2010.

We have the following comments on the report:

5.4 Excavation & Construction

We are pleased to see the ES will provide information on areas of contamination and the quantity of excavated material. Chapter 5 of the ES should incorporate issues related to dewatering of contaminated water and discharge during construction.

5.13 Water Resources, Drainage and Flood Risk

We have previously met and corresponded with Buro Happold and Treasury Holdings to discuss the scope of the Flood Risk Assessment, particularly with regard to the breach flood modelling and suitable forms of flood mitigation. We are satisfied with the proposed scope of the flood risk assessment (FRA).

We suggest that the FRA is included as an appendix to the main Environmental Statement report, which can be read independently.

5.14 Ground Conditions & Settlement

As above, we also suggest the impact of dewatering contaminated water should be addressed as part of the EIA.

We would be happy to review draft chapters of the ES and to provide any additional advice. Please let me know if you have any queries.

Environment Agency
30-34 Albert Embankment, London, SE1 7TL.
Customer services line: 08708 506 506
Email: enquiries@environment-agency.gov.uk
www.environment-agency.gov.uk

Yours sincerely

Ms Charlotte Amor
Major Projects Officer

[redacted]

Environment Agency
30-34 Albert Embankment, London, SE1 7TL.
Customer services line: 08708 506 506
Email: enquiries@environment-agency.gov.uk
www.environment-agency.gov.uk

Appendix A.7:

London Borough of Southwark Letter

Dated: 28/09/10

Ref. No.: 10-AP-2493

Southwark Council

Regeneration and neighbourhoods
Planning & transport
Development management
PO Box 64529
LONDON SE1P 5LX

Mr T. Whitehead
Treasury Holdings
Battersea Power Station
188 Kirtling Street
London
SW8 5BN

Your Ref:
Our Ref: 10-AP-2493
Contact: Adrian Dennis
Telephone: [redacted]
E-Mail: planning.applications@southwark.gov.uk
Web Site: http://www.southwark.gov.uk

Date: 28/09/2010

Dear Mr Whitehead

TOWN & COUNTRY PLANNING ACT 1990 (as amended)
APPLICATION FOR ENVIRONMENTAL IMPACT ASSESSMENT - SCOPING OPINION

Re: NORTHERN LINE EXTENSION

I refer to your proposal for development at the above site and enclose the Council's decision notice.

Should you have any queries regarding this, please contact the case officer, Adrian Dennis.

Yours sincerely [1]

Gary Rice
Head of Development management

Southwark Council

Regeneration and neighbourhoods
Planning & transport
Development management
PO Box 64529
LONDON SE1P 5LX

Mr T. Whitehead
Treasury Holdings
Battersea Power Station
188 Kirtling Street
London
SW8 5BN

Your Ref:
Our Ref: 10-AP-2493
Contact: Adrian Dennis
Telephone: [redacted]
E-Mail: planning.applications@southwark.gov.uk
Web Site: http://www.southwark.gov.uk

Date: 28/09/2010

Dear Mr Whitehead

TOWN & COUNTRY PLANNING ACT 1990 (as amended)
APPLICATION FOR ENVIRONMENTAL IMPACT ASSESSMENT - SCOPING OPINION

At: NORTHERN LINE EXTENSION
Proposal: Northern Line Extension (Transport and Works Act 1992): Observations on the EIA Scoping Report in relation sub-surface and above ground works associated with the extension of the Northern Line from Kennington to Vauxhall/Nine Elms/Battersea

Dear Mr Whitehead

Northern Line Extension: Environmental Impact Assessment Scoping.

On 20th August you wrote to this authority enclosing a scoping report and requesting comments. This document has been examined in order to assess the potential environmental impact of these proposals on occupiers who may be affected within the London Borough of Southwark Council.

We have the following comments to make on the scoping report:

1. The Code of Construction Practice (in paragraph 5.9 of draft) should include a section on plant and vehicle emissions and also to have a no bonfire policy.

2. The noise impact assessment should result in a Northern Line Extension noise and vibration policy statement. This should contain criteria for secondary / double glazing during the construction and operational phases of the project.

3. The description of Southwark's Air quality Management Area must be corrected (it is incorrect in paragraph 5.40 at present). Southwark's AQMA is entire Borough north of the South Circular Road A205.

4. Need to identify (and give details of) the traffic model being used.

5. There is a need for monitoring results to ascertain the degree of discharge from the ventilation shafts in the Borough (Paragraph 5.48). The authority has received complaints from residents in connection with particulate being emitted from ventilation on the Jubilee Line in the Rotherhithe, so these monitoring are essential. The reporting of the atmospheric emissions inventory (in paragraph 5.50) will need to take into account the London Atmospheric Emissions Inventory (LAEI) produced for the GLA by AEA technology.

6. The scoping report lists archaeological impacts as relating to construction sites, ventilation shafts, station sites and other constructional and operational impacts above the bored tunnel.
7. Paragraph 5.31 (within section 5.9) details a suitable range of sources for the chapter. Consultation with the relevant archaeology officer for the areas where the works are to occur is required to establish the baseline data.

8. There is a need for archaeological evaluations, trial trenching, to determine the nature, extent and importance of the archaeological interest of potential sites. Trial trenching is recommended in policy 6.1 of PPS5 and archaeology policy 3.19 of the Southwark Plan as a method of providing adequate information to enable planning applications to be determined. The desk-based assessment should also comply with GLAAS guidance documents, and the majority of the construction will be undertaken within areas covered by the Greater London Archaeology Advisory Service. These documents should be referenced within paragraph 5.34.

9. The limited and fairly general description of the proposed transport work to support the T&W Act Order seems to cover most of the Council's likely traffic interests. However, our particular concerns are:
   1. The routes followed by, and consequent impact of, construction traffic;
   2. The impact of any temporary road closures necessary to facilitate construction; and
   3. The impact of the extension on operations and capacity of the Northern Line, and in particular any impact it may have on crowding on trains arriving at Elephant & Castle, Borough and London Bridge stations

Yours sincerely

RP B. J. Connor
Adrian Dennis
Team Leader - Major Applications

Appendix A.8:

Thames Water Utilities Limited Letter

Dated: 18/10/10

Ref. No.: 6VKF/A5

FAO Mr. Tony Whitehead

Treasury Holdings Ltd
Battersea Power Station

188 Kirkling Street

London

SW8 5BN

Developer Services – Customer Led Team

Your ref
Our ref 6VKF/AJ
Name A.Jankiewicz
[redacted]

Date 18 October 2010

Dear Mr. Tony Whitehead

Northern Line Extension: The Transport and Works (Applications and Objections Procedure) (England and Wales) Rules 2006 – Environmental Impact Assessment Scope

Further to your letter dated 20 August 2010 regarding the above. Thank you for giving Thames Water early opportunity to comment on the above.

As you will probably be aware we have concerns regarding Waste Water Services and Water Supply Capacity in relation to the Battersea Power Station Site and the surrounding area. We have previously conveyed our concerns to the Council, this position has not changed. You will need to follow the usual processes when submitting your documentation. Beyond the usual routes I suggest you write to our Mark J. Dickinson in the first instance and copy me in at the same time to ensure things move forward as quickly as possible.

We have reviewed the EIA scoping document and have the following comments:

Thames Water Utilities Limited

Developer Services
Customer Led
3rd Floor West,
Clearwater Court
Reading,
Berkshire RG1 8DB

Postal Address:
c/o Reading Mail Room
Rose Kiln Court
Rose Kiln Lane, Reading
Berkshire RG2 0BY

I www.thames-water.com

With regards to the water resources:

· Groundwater has been generally considered but there is no specific mention of Battersea groundwater abstraction which is very close to the route at the western end of the proposed alignment.

· The Battersea abstraction was constructed to manage the rising groundwater levels in the deep chalk aquifer and therefore we think that the EIA should include the potential impact of the development to groundwater.

· Some consideration of the depth of the route is essential to assess the impact to our Battersea groundwater source and as such we would welcome any cross sections complementing the scoping document or any future documents.

· Clearly our Battersea groundwater abstraction needs to be considered in the EIA. However, the vertical tunnel alignment close to Battersea appears to be through the London Clay and not any part of the aquifer. There remains a potential risk to our abstraction from dewatering that may be required during tunnel and/or shaft construction through the Lambeth Group; clarification of dewatering requirements is needed.
· The route through the London Clay close to Battersea reduces our concern significantly, but clearly we will need confirmation that this is the option that will be delivered and also that the horizontal alignment does not pose a risk of disturbance of the borehole during construction, the latter will depend on construction methods.
· The EIA Scoping Report needs to consider our groundwater abstraction and the potential construction and, for completeness, the operational impacts.

It is also worth pointing out that Treasury Holdings Ltd. have their own proposal for abstracting water, this proposal should be discussed once the proposal has been defined, to ensure there are no conflicts.

With regard to the engineering aspects:
Thames Water has Clean Water and Waste Water assets in the vicinity with assets located at various levels:
· With regard to the Waste Water assets, although some Thames Water sewers appear to have been accounted for in the report all assets should be identified.
· With regard to the Clean Water assets we have Battersea WTW and the TWRM in the immediate vicinity plus large dia. trunk mains such as the Hampton 36".

We have been exploring the engineering aspects with Treasury Holdings Ltd and Halcrow. These requirements and considerations appear to be outside the scope of this scoping document, but never-the-less should be considered.

The scoping document should be updated to reflect any impacts on Thames Water's Tideway Project

Your item 3.6 *Subsurface Thames Water Ring Main* should be expanded to cover all Thames Water Clean Water and Waste assets

Your item 5.9 list should also include heave.

Once the chosen option has been identified then the scoping document should be updated to suit.

Thames Water operates a public water supply borehole at the Battersea WTW site. To ensure that there is no deterioration in water quality or volume, Thames Water will need to fully understand the proposed site investigation works and construction, with particular focus upon the foundation design, especially if it is to penetrate the aquifer. Thames Water has a statutory duty to protect where water abstraction sources may be impacted. Please ensure Thames Water is advised of any proposals and changes through the normal processes.

I hope the above helps with moving your proposals forward.

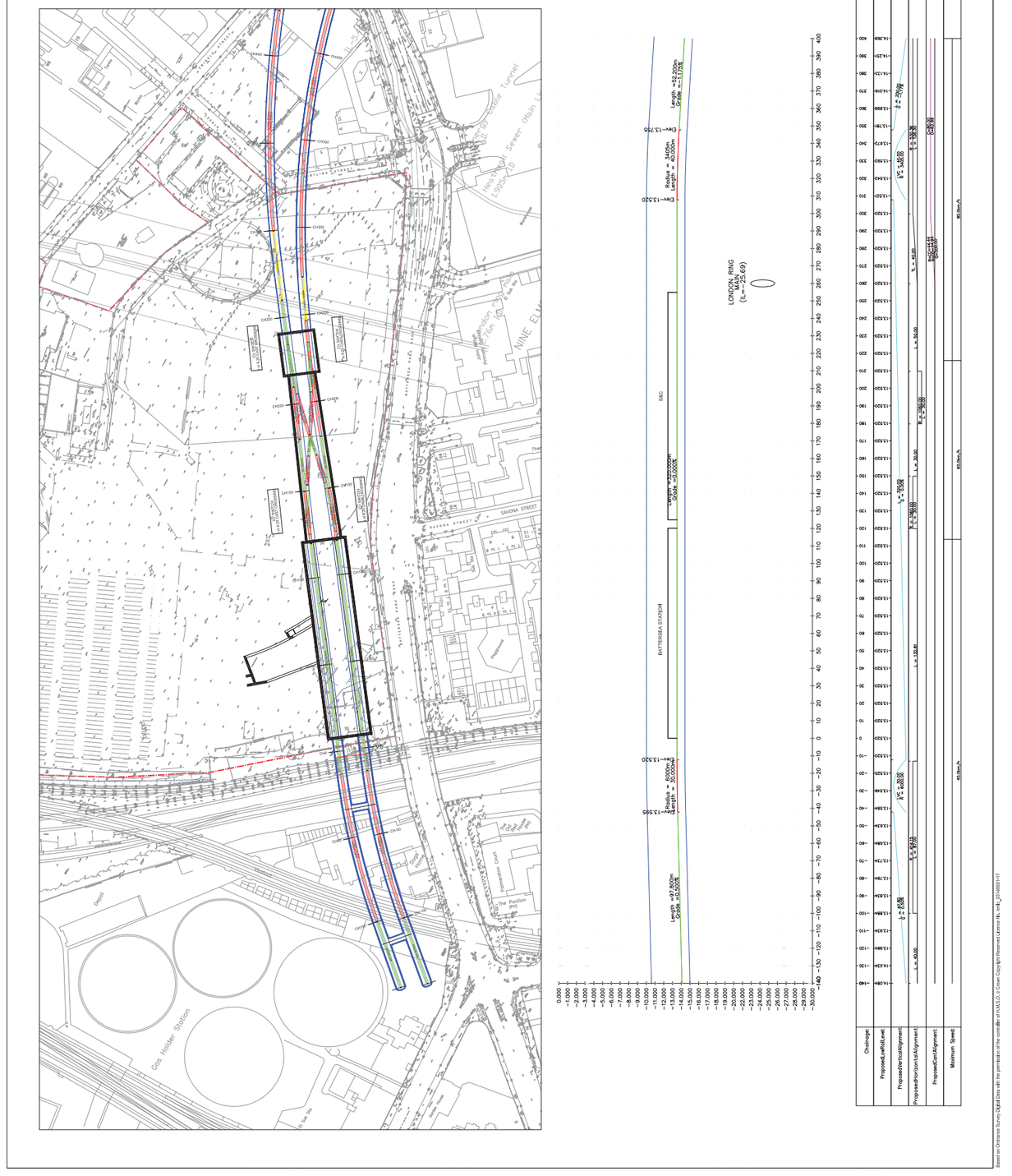
Yours sincerely

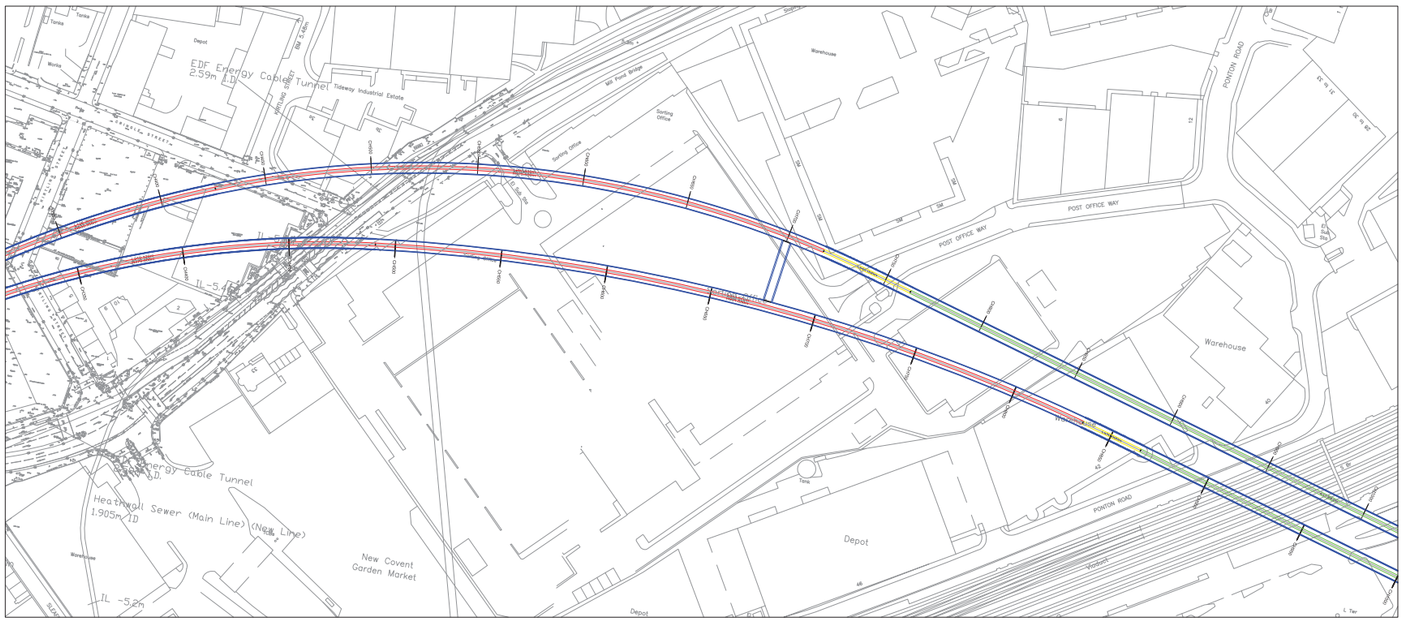
Andrew Jankiewicz

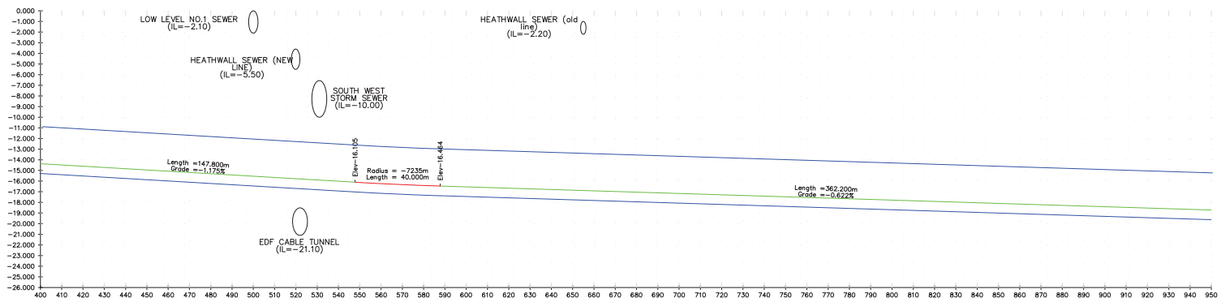
Andrew Jankiewicz
Senior Project Manager

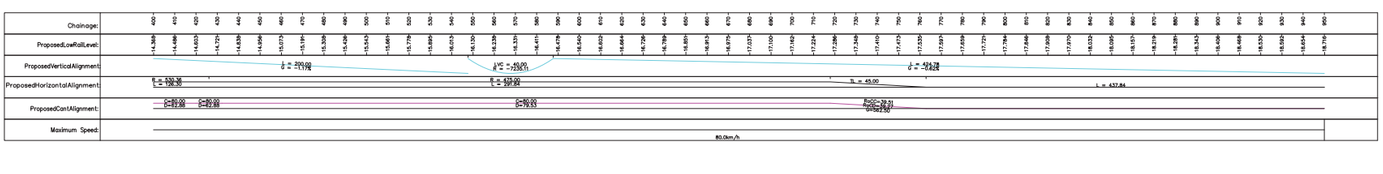
Appendix B:

Cross Sections showing Provisional Elevations









Location Plan - Northern Line

Notes:

KEY:

- Proposed Straight/Grade
- Proposed Curve
- Proposed Transition
- Proposed Cant Alignment
- Proposed Internal Tunnel Dimension

RoCD	Rate of Change of Deficiency
RoCC	Rate of Change of Cant
C	Cant
D	Deficiency
R	Radius
L	Length
TL	Transition Length
G	Gradient

Rev	By	Chkd	Apprvd	Date	Description
02	JOS	ROH	MAN	03/05/10	TITLE BLOCK AMENDMENT
01	JOS	ROH	MAN	25/05/10	FIRST DRAWN

Client: Real Estate Opportunities

studiodare | Buro Happold Consulting Engineers

Halcrow Group Limited
Vineyard House, 44 Brook Green, Hammersmith, London W6 7BY
Tel: +44 (0) 207602 7282 Fax: +44 (0) 20 7603 0095
VHReception@Halcrow.com
www.halcrow.com

Halcrow

Project: NORTHERN LINE EXTENSION TO BATTERSEA

Drawing:

NORTHBOUND HORIZONTAL AND VERTICAL TRACK ALIGNMENT DRAWING

Submitted by: S4 FORMAL ISSUE TO CLIENT

Drawn by: JOS	Date: 25/05/2010
Checked by: ROH	Date: 25/05/2010
Approved by: MAN	Date: 25/05/2010
Drawing No.	Revision
TTNLEB-HGL-00-XX-DR-PWY-20151	02-01

Drawing Scale: 1:1000

Drawing Breath & Frame - -

A2: May 2011 Scoping Response

Environmental Statement

Volume II

Appendix A2.1:

Cory Environmental

21/07/2011

Ref. No.: CD/P10/2

Our ref: CD/P10/2

Units 3-6
Greyfriars Business Park
Frank Foley Way
Greyfriars
Stafford, ST16 2ST
Tel: (01785) 251555
Fax: (01785) 251666
www.coryenvironmental.co.uk

Ms Juliette Seddon
URS/Scott Wilson
St George's House
5 St George's Road
Wimbledon
London
SW19 4DR

21st July 2011

Dear Ms Seddon

Northern Line Extension – Environmental Impact Assessment Scope

I write to you on behalf of Cory Environmental Limited ('Cory') in response to the recent Environmental Impact Assessment Scoping Report in relation to the proposed extension to the Northern Line.

Cory manages the operation of Cringle Dock Waste Transfer Station, which is located on Cringle Street in Battersea, on behalf of the Western Riverside Waste Authority. The Authority is responsible for recycling and disposing of residual waste collected by the London Boroughs of Hammersmith & Fulham, Lambeth, and Wandsworth and the Royal Borough of Kensington and Chelsea.

The Cringle Dock Waste Transfer Station handles a significant quantity of the Authority's residual waste which is delivered to the facility by road using Refuse Collection Vehicles (RCVs). Delivered waste is then compacted and placed into containers for onward river transport for final disposal via the safeguarded Cringle Dock Wharf.

Cringle Dock is safeguarded for the trans-shipment of freight (including aggregates and waste) by river within Policy 4C.9 of the London Plan and Policy PL 9 of the Wandsworth Core Strategy. These policies require that development next to or opposite to safeguarded wharves is designed to minimise the potential for conflicts of use and disturbance.

In reading the EIA Scoping Report it is not clear if a Navigation Risk Assessment will be included as part of the EIA or left to a later stage. The report (in paragraph 5.15) states that it is not viable to fully assess the navigational risks of barge movements for excavated material until the details of other expected major development in infrastructure projects which will use the River for cargo handling/muck away operations over the coming years are known.

The report goes onto state that a Spoil Management Plan will be provided for the Port of London Authority (PLA) which will provide details of volumes of excavated materials generated over the course of excavation and construction and the volumes to be

removed by barge. However, no timetable is suggested for the production of this document.

In order for the competent authority to determine this application and in turn properly consider the potential significant environmental effects of the scheme, we believe that the EIA should fully explore and assesses the opportunities to maximise off site transportation of spoil using the river while ensuring no detrimental impact on the navigation of existing vessel movements which currently use the River Thames, and maintaining the efficient operation of safeguarded wharves. Cory suggests that the early production of a draft Spoil Management Plan could help achieve this objective and be beneficial to the EIA process.

Cory recommends that these matters be taken account of as part of the scope of the EIA, such that they form an integral part of the Transport and Works Application documentation. We consider that this important EIA issue cannot be left for consideration at the reserved matter or pre commencement condition stage. We would also welcome an opportunity to contribute to the development of the Spoil Management Plan which is to be prepared to assist the PLA.

If you would like to discuss this matter further, please do not hesitate to contact me on 01785 251555 or by email at sholland@coryenvironmental.co.uk.

Please note that a copy of this response has also been sent to Steer Davies Gleave as our comments equally apply to the associated Transport Assessment Scope Report that they have prepared for this scheme.

Yours sincerely

pp

Sarah Holland
Planner

cc: Mark Broxup – Western Riverside Waste Authority
Neil Caborn – Cory (Thames) Limited
Fran Comerford Cole – Cory Environmental (London Operations) Limited
James Trimmer – Port of London Authority
Tony Whitehead – Treasury Holdings
Tim Cronin– London Borough of Wandsworth
Lee Mowle – Steer Davies Gleave

Appendix A2.2:

English Heritage

16/06/2011

ENGLISH HERITAGE

Northern Line Project Team
188 Kirtling Street
London
SW8 5BN

Our ref:
Your ref:

Telephone:
Fax:

BY E-MAIL: consultation@northernlineextension.com

16 June 2011

Dear Northern Line Project Team

Proposed Extension of the Northern Line to Nine Elms and Battersea – Preliminary Public Consultation

Thank you for the opportunity to provide comments on the Proposed Extension of the Northern Line to Nine Elms and Battersea. English Heritage is the government's advisor on all matters relating to the historic environment and a statutory consultee in respect of the Sustainability Appraisal (SA) of plans. We are therefore keen to ensure that the protection of the historic environment is fully taken into account at all stages of regional and local planning processes.

English Heritage supports the regeneration of the Battersea and Nine Elms areas in principle. We therefore support the introduction of the transport infrastructure necessary to facilitate such regeneration in principle as well.

We have assumed that the selected route is based on an analysis of the capacity of the London Underground system as a whole, and that a new spur on the Northern Line has been settled upon as the point with the most capacity for the system to accept an injection of new users. English Heritage's joint publication with CABE *Guidance on Tall Buildings* (July, 2007) identifies the significance of establishing a positive relationship between large-scale new development and transport infrastructure. We understand the development of a new section of the London Underground is vital for ensuring the viability of the new development and this underpins our 'in principle' support.

English Heritage notes the proposed locations of the two shafts necessary for the construction of the extension. The proposed locations on, and neighbouring, Kennington Green are both within the setting of a Grade II listed building. English Heritage recommends that the shaft be located on the distillery site as this would appear to present less impact on the cumulative heritage values in the area by avoiding harm to the composition of the Green and its surrounds. The two locations

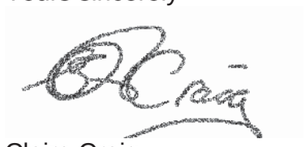
proposed in Kennington Park are both within a Grade II Registered Park and Garden of Historic Interest and we consider that they would both benefit from an impact assessment in order to determine which presents the least harmful impact on the heritage asset. The Claylands Road locations do not appear to impact on architectural heritage assets. All locations, however, may have archaeological potential. English Heritage consequently requests that the sites are subjected to a desk-based archaeological assessment which will indicate what further steps may be necessary in order to treat any archaeological resource in the vicinity of the development appropriately.

English Heritage welcomes the inclusion of questions concerning the improvement of the area around the construction sites and the naming of the stations. We would recommend consideration of how heritage assets in the vicinity of the sites could be enhanced or interpreted as part of any improvement works. We also consider that the naming of the stations represents an important opportunity to ensure that understanding of the historic continuum is maintained as the area undergoes profound change.

Thank you for the opportunity to provide comments on the initial consultation on the Proposed Extension of the Northern Line to Nine Elms and Battersea. It must be noted that this advice is based on the information provided by you and for the avoidance of doubt does not affect our obligation to advise you on, and potentially object to any specific development proposal which may subsequently arise from this, and which may have adverse effects on the environment.

I trust that this response is useful to your process and I would be glad to discuss any element of it with you should you deem it useful to do so.

Yours sincerely



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Please note that English Heritage operates an access to information policy.
Correspondence or information which you send us may therefore become publicly available

Appendix A2.1:

Environment Agency

20/07/2011

Ref. No.: SL/2010/107333/02-L10

creating a better place

Environment Agency

Mr Tony Whitehead
Treasury Holdings UK Ltd
Battersea Power Station (188) Kirtling Street
London
SW8 5BN

Our ref: SL/2010/107333/02-L01
Your ref: Tony Whitehead

Date: 20 July 2011

Dear Mr Whitehead

NORTHERN LINE EXTENSION: THE TRANSPORT AND WORKS (APPLICATIONS AND OBJECTIONS PROCEDURE) (ENGLAND AND WALES) RULES 2006 - ENVIRONMENTAL IMPACT ASSESSMENT SCOPE.

NORTHERN LINE EXTENSION, WANDSWORTH.

Thank you for your consulting the Environment Agency on the EIA Scoping Report Route 2 Option, dated May 2011. We have the following comments to make:

Flood risk assessment
We agree with the scoping recommendations for the points to be covered as part of the FRA process under the Water Resources section 5.73 onwards. We have held detailed discussions and meetings to date and reviewed pre-app modelling outputs which assess the risk of the sites, particularly from breach of the River Thames' tidal flood defences. All sources of flood risk should be addressed including surface water, groundwater and sewer flooding.

Groundwater
We are pleased to note that Section 5.86 now includes a commitment to assess potential impacts relating to contaminated dewatering and discharge, as requested in our response to the previous scoping report (please refer to our letter dated 11 October 2010, reference SL/2011/107333/01).

We would be happy to review draft chapters of the Environment Statement and to provide any additional advice. Please do not hesitate to contact me if you have any questions.

Yours sincerely

Ms Carly Pannell
Planning Liaison Officer

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30-34 Albert Embankment, London, SE1 7TL.
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A3: Strategy for Cumulative Impact Assessment

Environmental Statement

Volume II

URS

Northern Line Extension

Strategy for Cumulative Impact Assessment - FINAL

December 2012

46370144

Prepared for:
Transport for London

UNITED KINGDOM & IRELAND

REVISION RECORD

Rev	Date	Details	Prepared by	Reviewed by	Approved by
1	29th May 2012	Draft	Howard Waples (EIA Project Manager)	Martin Birt (Technical Director)	Martin Birt (Technical Director)
2	13th December 2012	Final	Fiona Wilson (Senior Consultant)	Howard Waples (EIA Project Manager)	Martin Birt (Technical Director)
3	30th January 2013		Fiona Wilson (Senior Consultant)	Howard Waples (EIA Project Manager)	Martin Birt (Technical Director)

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URS
Transport for London – Northern Line Extension

1 INTRODUCTION AND PURPOSE

As the Environmental Impact Assessment (EIA) project managers for the Northern Line Extension (NLE), URS will be assessing cumulative impacts, as required by the Town and Country Planning (Environmental Impact Assessment) Regulations (2011).

As set out in the guidance[1], cumulative impacts are impacts that result from incremental changes caused by other reasonably foreseeable works or developments, together with the NLE. There are two types of cumulative impact:

- The combined effect of individual impacts, for example noise, airborne dust or traffic on a single receptor; and
- The combined impacts of several development schemes which may, on an individual basis be insignificant but, cumulatively, have a significant impact.

This document is concerned only with the second type (the other will be discussed in the Environmental Statement). The guidance states:

> *"The effects to be considered cumulatively in an ES will be project specific and should be agreed with the* [Local Planning Authority] *LPA during the scoping stage. It is important that they are clearly identified in the ES, along with any assumptions made. In most cases, detailed consideration of the combined effects of the development proposed together with other developments will be limited to those others that are already begun or constructed or those that have not been commenced but have a valid planning permission".*

The purpose of this document is to clarify the approach, describe the assumptions made, and consult/inform the following organisations (i.e. the LPAs):

- London Borough of Wandsworth;
- London Borough of Lambeth;
- London Borough of Southwark;
- London Borough of Westminster;
- Greater London Authority.

This will then allow an accurate prediction of cumulative impacts, which is hoped could encourage a strategic level of mitigation[2].

2 THE LOCAL PLANNING CONTEXT OF THE NLE

The NLE passes through the London Boroughs of Wandsworth and Lambeth, and has a temporary shaft within LB Southwark. It is also close to the LB Westminster, although separated by the River Thames.

2.1 Inside the VNEB OA

The NLE is an integral part of the Vauxhall Nine Elms and Battersea Opportunity Area (VNEB OA), and is required to allow it to be developed to a capacity expected for an inner London

[1] Environmental Impact Assessment: A Guide to Good Practice and Procedure, A Consultation Draft, 2006, CLG
[2] The Authorities could use the principles set out in the document and the relative construction programmes of the major schemes to take appropriate action to ensure that they avoid overlapping of peak construction phases.

location. Therefore, 'Revised Option 5' set out in the VNEB OA Planning Framework (2012) has been assumed, i.e. that the VNEB OA is capable of delivering:

- 16,000 new homes;
- 300,000sqm of employment space at BPS (60,000 retail, 160,000 offices, 80,000 other employment);
- 200,000sqm of mixed employment on other sites (esp. Vauxhall and Nine Elms).

The BNP Paribas Report [3] states there are 61 sites for development in the VNEB OA, 36 in Wandsworth and 25 in Lambeth. These are listed in Table 1 (however, a map is not provided with the list).

3 Phasing of development and infrastructure requirements in the Vauxhall Nine Elms Battersea Opportunity Area; Feb 2012. BNP Paribas Real Estate.

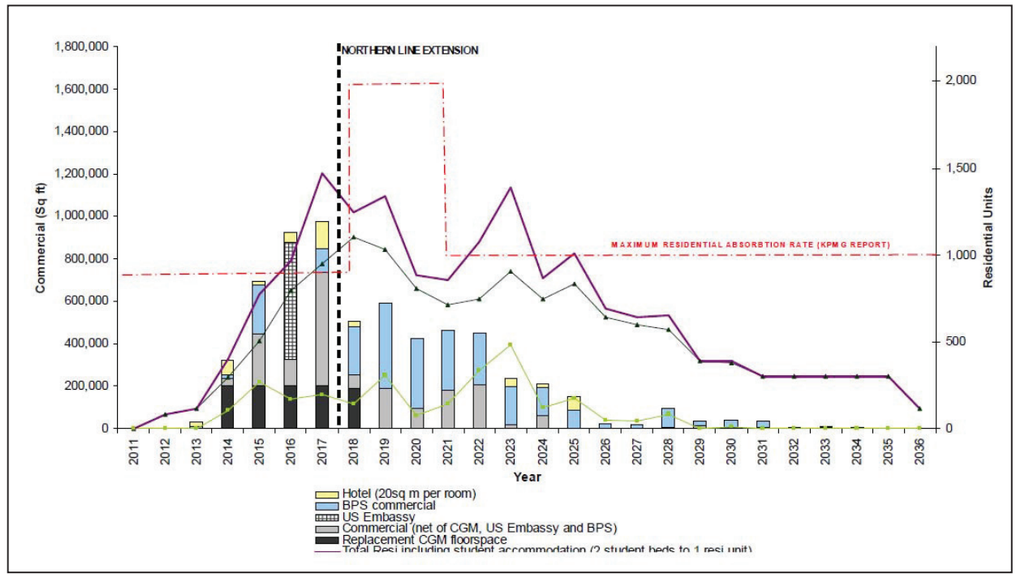
Table 1 VNEB OA Sites

Map ref	Site name	Map ref	Site name
1	49-59 Battersea Park Road	31	Adj 103-125 Battersea Pk Rd
2	88 Kirtling Street	32	Sleaford St Industrial Estate
3	Battersea Gasholders	33	Royal Mail Sorting Office
4	Battersea Power Station	34	Tidbury Ct, Stewarts Road
5	Battersea Studios	35	Tideway Industrial Estate, Kirtling St
6	Booker Cash and Carry	36	US Embassy
7	Brooks Court	37	*1 Wandsworth Road*
8	Cable and Wireless	38	*2-4 Tinworth Rd, 108-110 Vauxhall Wk*
9	Christies Auctioneers	39	*Albert Embankment Arch*
10	Coach Depot, Silverthorne Rd	40	*Albert Embankment riverside sites*
11	Cringle Dock	41	*Billboard site, Lambeth Road*
12	Depot, Kirtling Street	42	*80 South Lambeth Road*
13	Filling Stn, 2 Battersea Pk Rd	43	*Cobalt Sq (Met Police HQ)*
14	Govt Car Park	44	*Crnr Wandsworth Rd and Wyvil Rd*
15	Heathwell Pumping Stn	45	*Costa Brewing House*
16	Ingate Place	46	*Fire Stn, 8 Albert Embankment*
17	Main Ballymore site	47	*81 Black Prince Road*
18	Marco Polo House	48	*Hampton House*
19	Market Towers	49	*Miles St South & Cnr Wandsworth Rd*
20	Metro Greehham	50	*MPS Office building, 109 Lambeth Rd*
21	Met Police Warehouse	51	*Parry St East (Bondway South)*
22	Middle Wharf	52	*Sainsburys Nine Elms*
23	Milk Depot, 55 Sleaford St	53	*South Lambeth Place Bondway North*
24	New Covent Gdn Market	54	*Spring Gardens Railway Arch No 1*
25	New Covent Gdn Market	55	*Spring Gardens Railway Arch No 2*
26	New Covent Gdn Market	56	*St George Tower, Albert Embankment*
27	Operational Land, Cringle St	57	*Texaco Garage, 38-46 Albert Embkt*
28	Patcham Terrace	58	*Vauxhall Island site*
29	Securicor	59	*Vauxhall Station Arches*
30	Silverthorne Street	60	*Vauxhall Tavern, 372 Kennington Ln*
		61	*Warehouse, Lambeth High St*

Note: sites in blue are located in Wandsworth; sites in *red* are located in Lambeth

A number of scenarios were investigated in the BNPP Study regarding the likely phasing of all of this development. Phasing Scenarios 1 and 2 provide the most optimistically short timescales for delivery, and was based on responses to surveys by the landowners. Phasing Scenario 3 (Figure 1) assumes a slightly slower rate of delivery and Phasing Scenario 4 assumes the slowest delivery of development.

Figure 1 Phasing Scenario 3 from the BNPP Report



However, in each of these scenarios it is assumed that the NLE will be operational in early 2017, which is approximately 3 years before that currently expected by TfL (Q1 2020). In addition to this, there are a number of other uncertainties, such as the anticipated development programme for the redevelopment of Battersea Power Station (BPS) and the phasing assumptions of other schemes (e.g. certain parts of the BPS development can only begin once the extension is operational), it is considered that a robust approach is as described in the following sections.

2.2 Outside the VNEB OA

A number of other schemes outside the VNEB OA are close enough to the NLE to have potential cumulative impacts. The growth in this area is not driven by any policy designations such as Opportunity Areas, so it is assumed to lead to increases of population which is taken into account in the future year transport modelling. This is included in planning data which forms the basis of the London Transportation Studies (LTS) model which generates the operational travel demand in the modelling.

3 APPROACHES TO CUMULATIVE IMPACT ASSESSMENT

For the purposes of the EIA, two separate approaches are proposed for the assessment of cumulative impacts during construction and operation. The type of cumulative impacts assessed as part of the construction and operation phases are described in Table 2.

Table 2 Topics Considered as Part of Construction and Operational Cumulative Impact Assessment

Topic	Construction Impact	Operational Impact
Transport	QN. HGVs routing and numbers, impact on parking, pedestrians, cyclist, road closures. Cumulation of construction traffic and effects on nearby sensitive receptors.	QN. Traffic levels in 2031 with all cumulative schemes, the emerging public transport (specifically LU) improvements.
Noise and vibration	QN. Worksites being in close proximity and with overlapping timescales. Noise and vibration impacts from HGVs.	There will be no other sources of cumulative groundbourne noise, and the ventilation shafts are not expected to cause significant noise under normal operating conditions, and there will be little operational traffic. Therefore, there will be no cumulative operational impact.
Air Quality	QN. Worksites being in close proximity and with overlapping timescales. Emissions impacts from HGVs and construction plant. Dust from construction works.	The stations do not include their own building plant, so they will not produce direct operational emissions, and so will not have a cumulative operational impact.

Note. QL = qualitative assessment. QN = quantitative assessment

As precise details are not currently available, assumptions will be made with respect to construction programmes, construction methodologies for schemes that have been identified as having the potential for cumulative impacts (see Table 3).

There are a number of other environmental aspects being assessed as part of the EIA, for which there may be cumulative impacts. However, the VNEB OAPF has been produced taking into account the findings of a Sustainability Appraisal[4]. This assessed the development of the OA against a number of Sustainability Objectives, namely:

- Housing;
- Equality and Diversity;
- Education;
- Safety and Security;
- Health and Wellbeing;
- Transport and Travel;
- Stable Economy;
- Employment;
- Regeneration and Land Use;
- Heritage and the Built Environment;

4 Vauxhall Nine Elms Battersea Opportunity Area Planning Framework Sustainability Appraisal DRAFT; December 2009; Greater London Authority

- Open Space;
- Climate Change;
- Biodiversity;
- Natural Resources;
- Water Resources;
- Soil Conditions and Contamination;
- Waste; and
- Air Quality.

Precise details of the cumulative schemes are not available, and this therefore it is considered that the remaining topics of the NLE EIA have already been assessed strategically (and cumulatively) as part of the Draft Sustainability Appraisal. It is assumed that the LPAs will have a clear understanding as to the cumulative impacts, and therefore it is proposed that a detailed cumulative assessment is not carried out. However, a brief commentary will be provided in the appropriate chapter for the following topics:

- Socio-economics;
- Water resources and flood risk;
- Archaeology and built heritage;
- Townscape and Visual;
- Electromagnetism;
- Ecology;
- Climate change and adaptation.

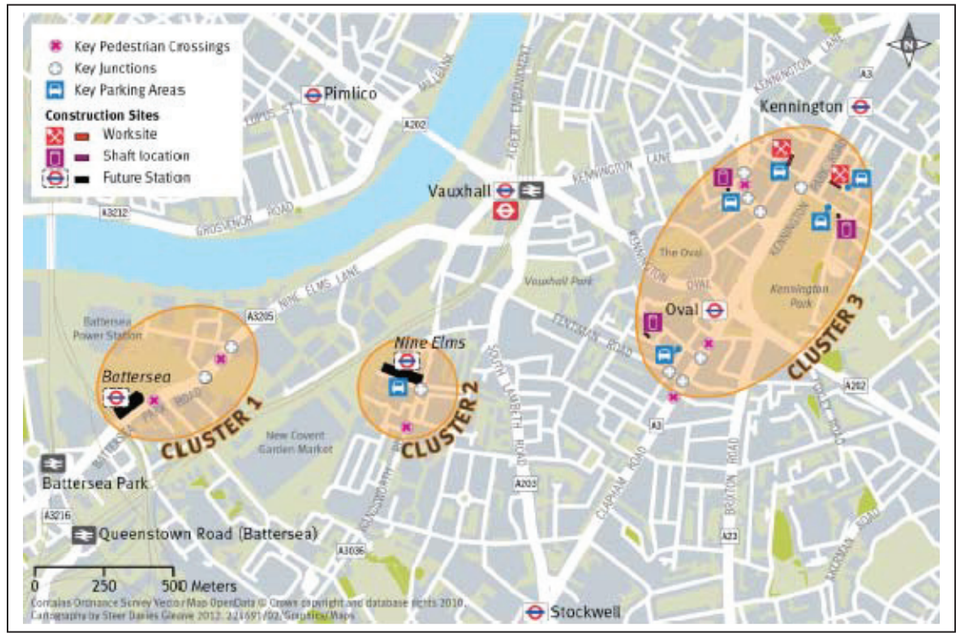
3.1 Cumulative Construction Impacts

With so many major projects being constructed in the local area in the coming years, there is a potential for some significant cumulative construction impacts, and therefore needs careful consideration. The anticipated NLE construction programme produced by Halcrow/TfL has been produced which allocates a timescale (which will be provided in the ES) against various construction activities at the six NLE worksites, as follows:

- Battersea Station;
- Nine Elms Station;
- Ventilation shaft at Kennington Park;
- Ventilation shaft at Kennington Green;
- Grout shaft 1 (Radcot Street); and
- Grout shaft 2 (Harmsworth Street).

Steer Davis Gleave have produced an Interim Report entitled 'NLE Construction: Traffic and Parking Impact Assessment' which considers 3 'clusters' of where construction traffic impacts will be assessed. This is shown in Figure 2

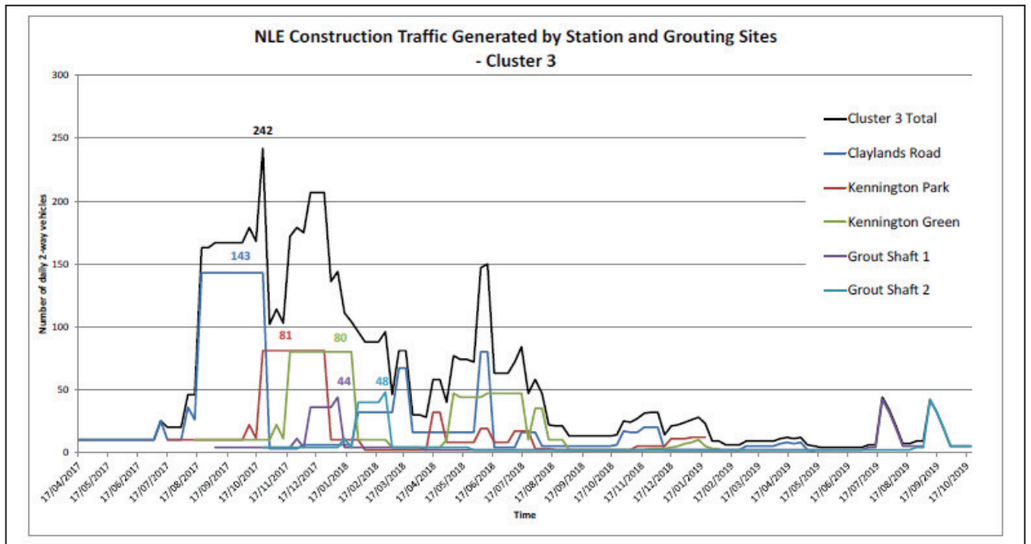
Figure 2 Locations of NLE Construction Sites and Study Area Clusters for Transport Impacts



Baseline traffic surveys have been undertaken and transport models produced in order to assess the likely impacts to the road network during construction of the NLE.

An example of how the daily two-way construction traffic generated by individual worksites in Cluster 3 can cause a cumulative impact within the Cluster is shown by the total in Figure 3.

Figure 3 Example of the Combined Daily Two-way Construction Traffic Generated by NLE Worksites in Cluster 3



Note – figure produced before Claylands Road worksite removed from design.

3.2 Cumulative Operational Impacts

NLE Operational Impacts will use a future assessment year of 2031 by which time it will be assumed that:

- All of the development in Revised Option 5 of the VNEB OA will have been built and all the housing will have been completed and occupied;
- Population and employment growth will have occurred at typical rates for London, as provided by the GLA, and consistent with those used in the Mayor's Transport Strategy and London Plan.

Figure 1 shows that the new VNEB OA housing might not be fully occupied until 2036, so this represents a more robust 'worst case' approach.

This future year also takes into account all committed and/or funded transport improvements, as outlined in the TfL Business Plan. This includes all LUL line upgrades.

4 IDENTIFICATION OF SCHEMES WITH POTENTIAL FOR CUMULATIVE CONSTRUCTION IMPACTS

For the assessment of cumulative construction impacts, only 'major projects' referable to the Mayor are considered, as these have the greatest potential to cause significant cumulative impacts, and more certainty can be established with respect to construction specific issues.

Only those schemes that are anticipated to share a construction programme and/or use the same roads for construction vehicles are considered to have the potential for cumulative construction impacts.

Table 3 lists all the major projects within a 1 kilometre buffer of the current route centre line, and provides details as to what the scheme involves, is current planning or construction status, and where details have not been identified, it provides an anticipated construction programme (and peak construction year). It also states the source of evidence and level of certainty of the assumptions, and makes a conclusion as to the potential for cumulative construction impacts (along with identifying what cluster these are likely to affect).

For the purposes of this assessment, it is assumed that there would be sufficient spatial separation of the NLE sites from LB Westminster (including by the River Thames), and construction traffic for that Borough would be unlikely to share the same local roads (instead approaching from the west and north). Chelsea Barracks is just outside the 1km buffer, and therefore, no projects in LB Westminster have been considered.

An initial draft of this document was submitted to LB Wandsworth, LB Lambeth and LB Southwark on 25/07/12 to obtain further detail for the known schemes, to confirm current understanding of construction and completion dates, and to ensure all cumulative schemes were included. Responses were received from the LB Wandsworth (15/08/12) and LB Lambeth (31/08/12) (see Annex 1), and the Comments and Responses Technical Memorandum for Thames Tideway Tunnel (Thames Water - September 2012) was reviewed.

Table 3 has therefore been updated with the feedback received, although due to the nature of construction projects there are still elements of uncertainty and the table should not be assumed to present definitive information.

A figure showing the location and current status of each scheme is shown in Figure 4.

Table 3 Schemes with Potential for Cumulative Construction Impacts

Map Ref	Cumulative Scheme	Description of Scheme	Status	Anticipated Construction Phasing	Source and certainty	Likelihood of Cumulative Constr Traffic Imp
1	Battersea Power Station, Wandsworth 2009/3575 2009/3576, 2009/3577 and 2009/3578 also accompany	The redevelopment of the site will create 3,400 new homes (private and affordable), 160,000 sqm of new office space, 56,000 sq m of retail and cover 9 hectares of public realm. Subsequent applications (and approvals) for demolition and repair to ancillary areas (including towers, jetty and pumping station)	Application Approved	Q4 2012 – Q2 2019 Peak year 2017	Based on assumption that Phase 1 beginning now, and based on TT Position paper.. Certainty: Medium	High. Cluster 1
2	Wah Kwong House, 10 Albert Embankment, Lambeth 11/00909/FUL	102 bed aparthotel together with restaurant and penthouse residential units.	Application Approved	Q3 2012 - Q4 2014 Peak year 2013.	Based on assumption Certainty: Low	Low. Will be complete prior to NLE construction.
3	1 Glyn Street, Lambeth 07/01681/FUL	The development involves the demolition of the existing warehouse and office building and redevelopment of the site for affordable residential accommodation comprising 69 units with a mix of 1, 2 and 3 bedroom self contained units, in a ground plus six storey building. The proposal also included a retail/café unit at ground floor.	Application Approved	Under construction – assumed complete by Q4 2013	Info obtained from: http://www.ridgeford.com/development-glyn-street.aspx Certainty: High	Low. Will be complete prior to NLE construction
4	Riverlight, Tideway Industrial Estate 2011/3748	Redevelopment to provide a residential led mixed use development of six buildings between 12 and 20 storeys (plus 2 basement levels) comprising 806 residential units. Also to provide flexible commercial uses, retail, restaurant, healthcare and leisure facilities.	Application Approved	Under construction Assumed complete by Q1 2015	Based on TT Position paper. LB Wandsworth state that the tail end of development is likely to overlap. Certainty: High	High. Cluster 1.
5	Hampton House, 20 Albert Embankment 07/04264/FUL	Construction of a 27 storey building with one 24 and one 13 storey building to provide a 167 room hotel, 242 residential units, 77 of which will be affordable, and ground floor retail.	Application Approved	Q1 2013 - Q4 2014	Based on TT Position paper. Certainty: Medium	Low. Will be complete prior to NLE construction

6	St George Wharf and Vauxhall Tower 11/00855/FUL 03/01501/FUL	A 93,000 sq m mixed use scheme overlooking the River Thames at Vauxhall Bridge. The development comprises of luxury apartments, retail units, offices and restaurant units, as well as a proposed health/fitness facility. A residential tower rising to 50 floors above ground, 180metres (590 feet) with 200 apartments and incorporating a wind turbine on the roof to power the internal lighting of the building.	Application Approved	Under construction. Completed by Q1 2014	Based on TT Position paper Certainty: High	Low. Will be complete prior to NLE construction
7	Kennington Oval 07/0459/FUL	Replacement of the existing Surrey Tavern and Lock, Laker and Peter May Stands and other minor associated buildings/structures to create a new plaza and the erection of a six-storey stand incorporating 1,632 additional spectator seats, hospitality and ancillary facilities, together with the erection of a new five-storey building with set back roof plant containing a 168 bedrooms hotel with top floor restaurant fronting Kennington Oval, and incorporating basement car park for 57 spaces, together with the erection of a new two-storey ticket/security office and turnstile system with associated landscaping and infrastructure	Application Approved	Q1 2018 – Q4 2019	Based on assumption, and from response from LB Lambeth saying that construction not likely to start from next 5 years. Certainty: Medium	High. Cluster 3.
8	Parliament House, 81 Black Prince Road 08/04454/FUL	The 11,150 sqm scheme contains a total of 101 flats, including private for sale, social rented and affordable housing, as well as 1,770 sqm of commercial development within its street scale podium base.	Application Approved	Q1 2014 – Q4 2015	Based on assumption Certainty: Low	Low. Will be complete prior to NLE construction
9	Land on south side of Nine Elms Lane incorporating Ponton Road (US Embassy) 2009/1506 2012/2759 (reserved matters)	Redevelopment of an area of 2.15 hectares to provide a new US Embassy to a maximum height of 97m. Associated buildings and new access road.	Application Approved	Q2 2013 - Q4 2017	Based on response from LB Wandsworth. Certainty: Medium	High. Cluster 1 and 2
10	Embassy Gardens, land to south of Nine Elms Lane comprising	Outline application for demolition of all existing buildings and construction of a mixed use development comprising 9	Application Approved	Under construction (demolition only) Phase 1 between 2013	Based on response from LB Wandsworth for Phase 1 and assumption for other Phases.	High. Cluster 1 and 2

	DHL Depot and 1-12 Ponton Road and 51 Nine Elms Lane 2011/1815	building plots, with buildings up to 23 storeys and maximum overall floorspace of 263,030sqm GEA. Provides residential units, financial/professional services, café/restaurant/bar, car showroom, office, hotel, community and leisure space.		– 2017, other Phases to follow (assume up to Q1 2020)	Certainty: Medium	
11	Vauxhall Sky Gardens (143-161 Wandsworth Road) 09/04322/FUL	Redevelopment for residential-led mixed use purposes comprising a part-3, part-6 and part-36 storey building (120 metres high) to provide 239 residential units, 4,722 sq. m. of commercial (B1 office) floorspace, 257 sq. m. of retail or community floorspace, amenity space and new vehicular access.	Application Approved	Q2 2013 – Q2 2015	Based on assumption and completion date in TT Position paper Certainty: Medium	High, Cluster 1
12	Thames Tunnel, Kirtling Street Worksite No planning ref.	Construction work and permanent structures required to operate the main Thames Tunnel. The site would be used to drive the of the main tunnel in two directions to Chambers Wharf and to Carnwath Road Riverside and would be used to temporarily store and then off-load excavated material.	Application pending	Q1 2016 – Q1 2023 Peak construction year 2016	2018 is peak year (based on TT EIA construction logistics strategy). Certainty: Medium	High, Cluster 1
13	Post Office Depot, South London Mail Centre, Nine Elms Lane (Parkside) 2011/2462	Outline planning application for demolition of existing buildings and construction of a mixed use redevelopment comprising 7 buildings up to 23 storeys and maximum overall floorspace of 222,120 sqm.	Application approved	Q1 2016 – Q4 2023 Peak construction year 2017	Based on response from LB Wandsworth and TT Position Paper. Certainty: Medium	High. Cluster 1 & 4
14	New Covent Garden Market 2011/4664 12/00289/OBS (Lambeth Observation record)	In total the application seeks outline consent for 426,874 sq m of development which will deliver modern new market facilities and a new food centre for London, paid for by developing homes, shops, commercial space, a hotel and public open space on parts of the site not needed for the new market.	Application approved	Q1 2014 –Q2 2023 Peak construction year 2016.	Commencement year based on response from LB Wandsworth, and end date and peak year based on assumption and TT Position paper. Certainty: Medium	High. Cluster 1 and 2
15	Sainsburys 62 Wandsworth Road London 11/02326/OUT	Part detailed, part outline application for demolition of existing retail store and petrol station allowing for replacement retail store and additional services, retail and residential units with ancillary units arranged in seven blocks including towers of 19. 28, and 37 storeys, with associated retail,	Application approved	Q1 2012 – Q1 2019 Peak Construction year 2015	Based on input from LB Lambeth Certainty: Medium	High. Cluster 2.

		residential parking spaces, cycle spaces, open space, children's play space, landscaping and public realm improvements. Outline planning for flexible floorspace and dwellings.				
16	Eastbury House 30 - 34 Albert Embankment 12/01768/FUL	Demolition of the existing building and the erection of a part 14, part 21, part 28 storey building to provide a mixed use scheme incorporating: ground floor cafe/retail unit (A1/A3) and public piazza, office accommodation (B1) and 48 residential units, together with basement car and cycle parking and plant equipment	Application approved	Q2 2013 – Q2 2015 Peak construction year 2014	Dates based on assumption. Planning status based on input from LB Lambeth,	High. Cluster 1, 2 & 3.
17	8 Albert Embankment, London Fire Brigade Headquarters 10/04473/FUL	Demolition of the brigade workshop/office buildings to the rear of the fire station. Construction of 7 new buildings ranging in height from 5 to 15 storeys for mixed use purposes... The development would provide a total of 276 residential units, a 2,721 sqm fire station, 8,554 sqm of commercial floorspace (use Class B1), 696 sqm of retail/A Class floorspace and 161 car parking spaces.	Under appeal, new application pending	Q2 2013 – Q2 2015 Peak construction year 2014	Dates based on assumption, planning status based on input from LB Lambeth. Certainty: Medium	High. Cluster 1, 2 & 3.
18	Island Site Vauxhall Cross 10/02060/FUL	Erection of two towers, Tower A rising to 41 storeys (approx 140m) and Tower B rising to 32 storeys (approx 115m), plus 4 basement levels below ground; to provide a mixed use development comprising 291 residential units (made up of 225 market units, 42 socially rented, 42 intermediate, which makes 23% of the units affordable, 663 sqm of floorspace for food and drink commercial uses, 2,162 sqm of floorspace for employment commercial uses, a 179 room hotel and 1,371 sqm of floorspace for community facilities/ assembly and leisure (consisting of a dentist surgery, a soft play facility and a digital cinema/ performance space)	Application approved	Q2 2013 – Q4 2016 Peak construction year 2015	Start date based on assumption, and date based on TT Position paper. Certainty: Medium	High. Cluster 1, 2 & 3.
19	CLS Vauxhall Square 11/04428/FUL	Demolition of existing buildings (except for the listed buildings on site) to provide a mixed use scheme comprising eight blocks ranging between 6, 9, 11, 16, 21, 26, 48 and 50 storeys, which include 604 dwellings, 14,722sqm Gross Internal Area (GIA)	Application submitted	Q1 2015 – Q4 2019 Peak construction year 2017	http://www.vauxhallsquare.co.uk/ states potential start on site Early 2015 dependent on planning decision. Dates also based on TT Position paper.	High. Cluster 1, 2 & 3.

		of new office floor space (B1), 3047sqm GIA of A1-A5 retail, 438 bedroom hotel (C1), 40 bedroom replacement homeless hostel (sui generis), 416 student rooms (C1), new multi-screen cinema (D2), 1167sqm GIA Gym (D2), associated basement car parking and servicing; new public square and children's play area and associated public realm improvements.			Certainty: Medium	
20	30-60 South Lambeth Road 11/04181/FUL	Redevelopment of the existing site to provide a 32 storey mixed-use building comprising new leisure uses (swimming pool & gymnasium) and 572 units for student residential accommodation. Provision of refuse and cycle storage, disabled parking and associated landscaping.	Under construction	Q3 2012 – Q4 2014 Peak construction year 2013	http://www.downingvauxhall.blogspot.co.uk/2011/12/planning-application-submitted-for-30.html states potential construction start 2012 dependent on planning decision Based on TT Position paper. Certainty: High	Low. Will be complete prior to NLE construction
21	Spring Mews, Vauxhall Walk 11/04510/FUL	Redevelopment of 2-16 (evens) Tinworth Street and 100-110 Vauxhall Walk to provide a mixed use scheme comprising a range of buildings up to 8 storeys in height; providing a 120 bedroom hotel (4,706sqm GIA), student accommodation and associated support facilities including 399 student bedrooms (13,141sqm GIA), a convenience retail store (346sqm GIA), a series of small business units (use class B1 - totalling 467sqm GIA) a replacement community centre (561sqm GIA), associated basement servicing area, new public realm, public realm improvements and disabled parking. |	Application approved	Q4 2012 – Q1 2015 Peak construction year 2013	http://www.springmews.co.uk/ states construction starts early September 2012. Certainty: High	Low. Will be complete prior to NLE construction
22	Battersea Plant, Nine Elms Lane Goods Yard, Cringle Street 2012/0764	Redevelopment and consolidation of the site will involve the demolition of the existing concrete plant, conveyor gantry, aggregate storage bins and related structures, construction of replacement concrete plant, aggregates storage facility and ancillary office units, hardstanding and landscaping and redesign of the access	Application approved	Q2 2013 – Q4 2014. Peak construction year 2014	Start date based on assumption, end date based on TT Position paper. Certainty: Medium	High. Cluster 1

23	Nine Elms Pier 2011/1928	Demolition of the existing pier and erection of a new marina to provide permanent moorings for up to 33 houseboats and moorings for up to 2 visitor boats; including construction of a single storey ancillary structure on the marina to provide studio, office, storage and utilities space with a landscaped roof terrace above. [REVISED SCHEME - Amendments include: revised arrangement of the boats, a reduction in the number of permanent moorings from 37 to 33, relocation of impact protection barriers]	Application submitted	Q3 2013 - Q1 2023 Peak construction year 2015	Start date based on assumptions, end date based on TT Position paper. Certainty: Medium	High. Cluster 1.
24	Marco Polo House, 346 Queenstown Road 2011/2089	Demolition of existing building. Erection of two new buildings of up to 17 storeys and 15 storeys high to provide 456 residential units and 1,257 sq.m. of commercial floor area comprising of office (B1 & A2), retail (A1) and cafe/restaurant (A3) uses, together with new pedestrian link and vehicular access, basement car and cycle parking, landscaping, excavation works and servicing.	Application approved	Q4 2014 – Q4 2021 Peak construction year 2016	Based on input from LB Wandsworth and TT Position paper. Certainty: Medium	High. Cluster 1.
25	Market Towers 2012/0380	Demolition of existing buildings and structures. Erection of two new buildings of 58 storeys (up to 200m above ground) and 43 storeys (up to 161m above ground) high to up to: 77,548 sq.m. of residential floorspace (up to 491 units); 721 sq.m. of retail uses; 10,986 sq.m. of office space; 11,617 sq.m. hotel; provision of private and public open spaces; vehicular access and reconfigured vehicular access routes; provision of cycle, motorcycle and car parking, servicing and energy centre within two level basement; landscaping; excavation works; and other associated works.	Application approved	Q4 2014 – Q4 2020 Peak construction year 2016	Based on input from LB Wandsworth and TT Position paper. Certainty: Medium.	High. Cluster 1, 2 and 3.
26	1-9 Bondway and 4-6 South Lambeth Place 10/03151/FUL	Redevelopment of the site involving the demolition of the existing buildings and the erection of a 6 storey building (plus lower ground floor level) to provide a hotel comprising of 148 bedrooms (Use Class C1) with ancillary bar/ restaurant facilities along	Application approved	Q1 2014 - Q1 2016. Peak construction year 2015	Start date based on assumptions, end date based on TT Position paper. Certainty Medium	High. Cluster 1, 2 and 3.

		with commercial floorspace at ground floor level in either Use Classes A1 (retail), A2 (financial and professional services), A3 (restaurants and cafes), A4 (drinking establishments) and formation of roof level plant [Amended Plans]				

4.1 Estimating Cumulative Construction Traffic

Once the schemes with high likelihood of cumulative construction impacts have been identified, details on the number of two-way HGV movements will be obtained from a review of the respective planning applications, or where this is not obtained, it will be estimated by TfL based upon professional experience.

Likewise, any known details of the HGV routing and potential road closures associated with the cumulative schemes will be considered.

These HGV numbers (and road closures) will be added to those from the various worksites within the 3 clusters, and presented in a similar way to that shown in Figure 3.

5 NEXT STEPS

It is requested that the stakeholders listed in Section 1 review this list and provide any further comment on the approach to the approach to the cumulative effects strategy, and contents of Table 3, by 08/01/13, following which this list will be frozen for the purposes of undertaking the EIA.

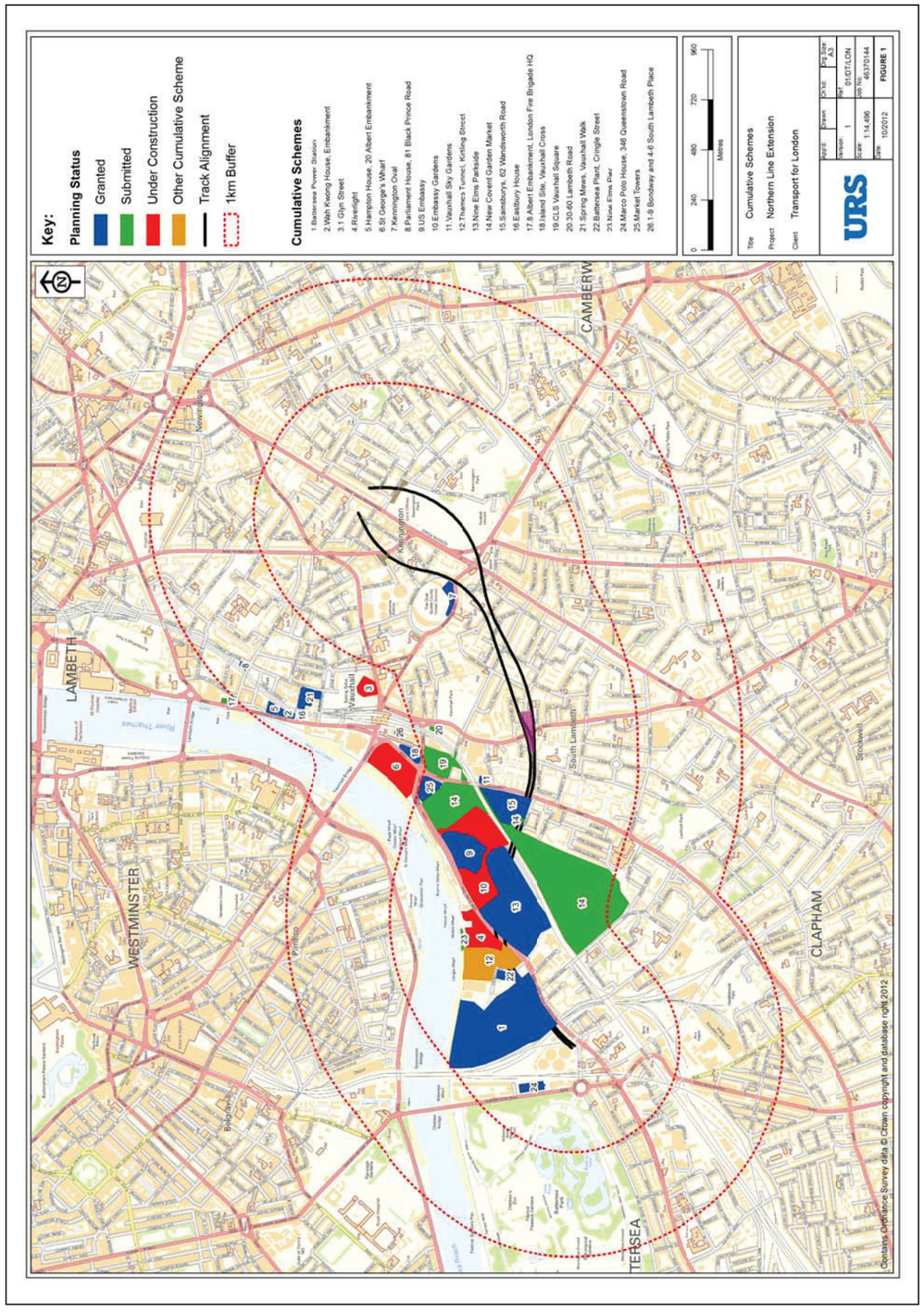


Figure 4 Location and Status of NLE Cumulative Schemes

B: NLE Material Management Strategy

Environmental Statement

Volume II

B1 Materials Management Strategy

Introduction

1.1 This appendix sets out the strategy for the management of materials generated during the construction of the Northern Line Extension (NLE). It has been prepared by URS in collaboration with the wider design team including TfL, Halcrow and Buro Happold.

1.2 This report describes how the construction of the NLE is likely to require significant quantities of building material, and is likely to generate large quantities of surplus material. The majority of this will be clean excavated material with the potential for a small amount of contaminated material to be present. There will also be materials arising through the demolition of buildings and wastage from construction activities.

1.3 It also describes how TfL will apply the principles of the waste hierarchy to divert surplus material from landfill wherever reasonably practicable.

Scope and Objectives

1.4 The scope of this Materials Management Strategy includes:

- A description of the main construction elements of the project in relation to the production of surplus material;
- A review of relevant policies, guidance and strategic objectives;
- A description of the material types and quantities of materials generated by the construction of the NLE; and
- A description of the proposals for the management of material both in accordance with the waste hierarchy and sustainable good practice, including a description of the transportation of surplus excavated materials.

1.5 Operational waste management (from the two proposed stations) is described in the Design and Access Statement which is included as *Appendix M* of this ES.

Site Waste Management Plan

1.6 In addition to this Materials Management Strategy a Site Waste Management Plan (SWMP) will be produced by the appointed Contractor in accordance with the Site Waste Management Plan Regulations 2008 (Ref. 1-1) and with the Non-Statutory Guidance for SWMPs prepared by DEFRA in April 2008 (Ref. 1-2). This document will be updated every six months as a minimum and will include the following:

- The site location and the estimated project cost;
- Details of the client, the principal contractor and the person who drafted the SWMP;
- All decision taken to minimise the quantity of waste produced on site;
- A description of each anticipated waste type;
- An estimate of the quantity of waste for each waste stream;
- The proposed waste management action for each waste type;
- A declaration that all waste produced on the site will be dealt with in accordance with the waste duty of care; and
- A declaration that TfL's targets for recovery, reuse and recycling will be met i.e. materials will be handled in accordance with the waste hierarchy and managed appropriately. It is expected that at least 95% (by weight or by volume) of non-hazardous construction, demolition and excavation waste (CD&E) generated by the NLE will be diverted from landfill with an aspiration to divert 100% of non-hazardous waste.

Overview of the Construction Methodology

1.7 The proposed NLE route connects the existing Northern line on each side of the Kennington Loop and proceeds via an intermediate station at Nine Elms to a terminus station at Battersea Power Station. Further details of the development are provided *in Chapter 4: Description of the NLE* of this ES.

1.8 There are two construction methodologies proposed for the construction of the NLE, the 'Reference Design' (hereon referred to Construction Option A) and the 'Alternative Sprayed Concrete Lining (SCL) Design' (hereon referred to as Construction Option B) these are described in detail in *Chapter 4, Description of the NLE* of this ES.

1.9 Surplus excavated materials are anticipated to be generated during the following elements of the construction of the NLE:

- Removal of material from the excavation of the Battersea Station Box (removed by barge);
- Removal of material from the over-run tunnels and platform tunnels at Battersea (removed by barge);
- Step plate junctions;
- Launching of 2 Tunnel Boring Machines (TBMs) heading east (material removed by barge); and
- Removal of material from the excavation of the station box at Nine Elms and the shafts at Kennington Park and Kennington Green (removed by road).

1.10 Construction Option A requires the temporary shafts to be dug and the short length of tunnel to the Kennington Loop to be dug by hand to form step plate junctions (excavated material would be removed by road). The TBMs would drive all the way up to the temporary shafts where they would be dismantled (but excavated materials would be removed by barge).

1.11 Construction Option B does not require the temporary shafts, and the TBM would only drive up to the permanent shafts where it would be dismantled. The remaining length of the SCL tunnel (approximately 97m from Kennington Park and 172m from Kennington Green) would be hand or machine (non TBM) excavated, subsequent to the gallery tunnels being constructed parallel for grouting purposes which also would be hand or machine excavated (non TBM)) and material would be removed by road.

Policy and Guidance

1.12 Best Practicable Environmental Option (BPEO) will be used to manage the surplus material produced during the construction of the NLE. A full BPEO study has not been carried out for the NLE instead decisions have been based on the research done for similar projects such as Crossrail (Ref. 1-3) and the London 2012 Olympics (Ref. 1-4) and a review of the requirements of the relevant policy and guidance below.

1.13 There is a wide range of legislation, policy and guidance pertaining to waste and resource management. However this section only summarises the key parts of legislation and policy that are directly relevant to the NLE.

1.14 The NLE has been designed in accordance with this policy and guidance to meet the required objectives where practicable. This Materials Management Strategy together with the Project *Sustainability Appraisal Report in Appendix B3* of ES Volume II further illustrate the commitment to these requirements.

European Directives

The Waste Framework Directive

1.15 The Waste Framework Directive (Ref. 1-5) is the primary European legislation for the management of waste and includes a common definition of waste.

1.16 The Waste Framework Directive place great emphasis on the waste hierarchy to ensure that waste is dealt with in the priority order of:

- Prevention;
- Re-use;
- Recycling;
- Recovery (for example, energy recovery);
- Disposal.

1.17 The Waste (England and Wales) Regulations 2011 (as amended 2012) implement the Waste Framework Directive and enforce the requirement for waste permits and authorisations for certain activities.

National Legislation

1.18 Most of the key UK waste related legislation has been derived from European Union (EU) Directives. These EU Directives are transposed into UK law via the following legislative instruments:

- Clean Neighbourhoods and Environment Act 2005 (HMSO) (Ref. 1-6);
- Control of Pollution (Amendment) Act 1989 (COPA) (Ref. 1-7);
- The Environment Act 1995 (Ref. 1-8);
- The Environmental Protection Act 1990 (EPA) (Ref. 1-9);
- The Animal By-Products (Enforcement) (England) Regulations 2011 (ABPA) (Ref. 1-10);
- The Controlled Waste (England and Wales) Regulations 2012 (Ref. 1-11);
- The Environmental Permitting (England and Wales) Regulations 2012 (Ref. 1-12);
- The Waste (England and Wales) Regulations 2011 (Ref. 1-13);
- The Hazardous Waste (England and Wales) (Amendment) Regulations 2009 (Ref. 1-14);
- The List of Wastes (England) (Amendment) Regulations 2005 (Ref. 1-15);
- The Packaging (Essential Requirements) (Amendment) Regulations 2009 (Ref. 1-16);
- The Producer Responsibility Obligations (Packaging Waste) (Amendment) Regulations 2010 (Ref. 1-17);
- The Site Waste Management Plans Regulations 2008 (Ref. 1-1);
- The Waste Batteries and Accumulator Regulations 2009 (Ref. 1-18);
- The Waste Electrical & Electronic Equipment (WEEE) (Amendment) Regulations 2010 (Ref. 1-19); and
- The Waste (England and Wales) Regulations 2011 (as amended 2012) (Ref. 1-20).

National Policy

Waste Strategy for England 2007

1.19 The National Strategy for Waste (Ref. 1-22) sets out the Government's views on waste management in England. The main elements of the waste strategy are to:

- Give incentives to reduce, re-use, recycle and recover energy from waste;
- Reform regulation to drive the reduction of waste and diversion from landfill while reducing costs to compliant business and the regulators;
- Target action on materials, products and sectors with the greatest scope for improving environmental and economic outcomes;
- Stimulate investment in collection, recycling and recovery infrastructure and markets for recovered materials that will maximise the value of materials and energy recovered; and
- Improve national, regional and local governance with a clearer performance and institutional framework to deliver better coordinated action and services on the ground.

1.20 The Strategy commits to setting new national targets for the reduction of household waste through recycling and composting by at least 45% by 2015 and 50% by 2020, in comparison to 2000 levels.

Strategy for Sustainable Construction 2008

1.21 The Strategy for Sustainable Construction (Ref. 1-23) sets out measures to promote excellent design and innovation, to improve the sustainability of construction works. It sets the following target in relation to waste:

> *"By 2012, a 50% reduction of construction, demolition and excavation waste to landfill compared to 2008".*

1.22 It also sets the following target in relation to materials:

> *"That the materials used in construction have the least environmental and social impact as is feasible both socially and economically".*

Government Review of Waste Policy in England 2011

1.23 In order to ensure that the UK is on the path towards a 'zero waste' economy, a review of all waste policy in England was undertaken (Ref. 1-24). The review found that waste management has made significant progress in the last ten years with:

- Waste going to landfill having nearly halved since 2000;
- Household recycling rates having climbed to 40%;
- Waste generated from business declining by 29% from 2003 to 2009; and
- Business recycling rates increasing above 50%.

1.24 However the review identified a number of challenges, most notably ensuring waste prevention wherever possible.

National Planning Policy Framework

1.25 The National Planning Policy Framework (NPPF) (Ref. 1-25) was published on the 27 March 2012 and states that the Framework does not contain specific waste policies and that the Waste Planning Policy Statement (Planning Policy Statement 10: Planning for

Sustainable Waste Management (PPS10) (Ref. 1-26) will remain in place until the National Waste Management Plan for England is published.

Planning Policy Statement 10: Planning for Sustainable Waste Management

1.26 PPS10 will remain a material planning consideration until the National Waste Management Plan is published. PPS10 provides policy advice to help Councils and individual developers deliver waste management facilities and to manage waste more effectively. The overall objective of PPS10 is to protect human health and the environment by producing less waste and by using it as a resource wherever possible. PPS10 requires that planning authorities prepare strategies that deliver the following objectives:

- Help deliver sustainable development through driving waste management up the waste hierarchy, addressing waste as a resource and looking to disposal as the last option;
- Provide a framework in which communities take more responsibility for their own waste, and enable sufficient and timely provision of waste management facilities to meet the needs of their communities;
- Help implement the key objectives and targets from the National Strategy for Waste; and ensure consistency with obligations required under European waste legislation and other relevant guidance and legal controls;
- Help secure the recovery or disposal of waste without harming the environment; and enable waste to be disposed of in the nearest appropriate installation;
- Reflect the concerns and interests of communities, the needs of waste collection authorities, waste disposal authorities and business; and encourage competitiveness;
- Protect green belts but recognise the particular needs of some types of waste management facilities when defining detailed green belt boundaries; and
- Ensure the design and layout of new development supports sustainable waste management.

Regional Planning Policy

The London Plan 2011

1.27 The London Plan (Ref. 1-27) outlines the Mayor's commitment to making better use of waste and management of London's limited aggregate reserves in an attempt to reduce London's impact on climate change. The London Plan describes London's waste as a valuable resource that can be exploited for London's environmental, economic and social benefit. The London Plan emphasises the importance of the following policies in relation to waste and these are outlined in Table 1-1.

Table 1– 1 The London Plan 2011 Waste Management Policies

Policy	Description
Policy 5.3 Sustainable Design and Construction	States that the highest standard of sustainable design and construction should be achieved in developments to improve the environmental performance of new developments. This should be achieved through a number of sustainable design principles including minimising the generation of waste and maximising reuse and recycling.
Policy 5.16 Waste Self-sufficiency	States that the Mayor will work with various stakeholder and authorities to ensure that by 2031, 100% of London's waste will be managed within London and zero biodegradable or recyclable waste will be sent to landfill. In addition it states that the mayor will create positive environmental and economic impacts from waste processing. This will be achieved by: • Minimising waste; • Encouraging the reuse and reduction in the use of materials; • Exceeding recycling and composition levels in Municipal Solid Waste (MSW) of 45% by 2015; 50% by 2020 and aspiring to achieve 60% by 2031; • Exceeding recycling/ composting levels in C&I waste of 70% by 2020; • Exceeding recycling and reuse levels in construction, demolition and excavation (CDE) waste of 95% per 2020; • Improving London's near self-sufficiency though reducing the proportion of waste exported from the capital over time; and • Working with neighbouring regional and district authorities to co-ordinate strategic waste management across the greater south east of London.
Policy 5.17 Waste Capacity	States the need to increase the waste processing capacity in London and that all new developments should have suitable waste and recycling storage facilities
Policy 5.18 Construction, Excavation and Demolition Waste	States that waste should be removed from construction sites, and materials brought to the Site, by water or rail transport wherever that is practicable.

The GLA Supplementary Planning Guidance - Sustainable Design and Construction

1.28 The GLA Supplementary Planning Guidance (SPG) (Ref. 1-28) was produced to promote sustainable construction across London. Key standards were set for a range of

sustainability issues, including sourcing of materials and waste management. The SPG sets standards for the sourcing of materials (section 2.3.3) and waste management within new developments (section 2.7). Essential standards of waste management schemes for new developments should ensure that:

- Demolition waste is minimised, reused and recycled as much as physically practicable;
- The re-use or recycling of construction materials are specified; and
- Recycling facilities should be made as easy to access as waste facilities.

1.29 The Mayor's preferred standards within waste management practices include:

- The use of prefabricated and standardised modulation components to minimise waste. If this is not feasible, low waste fabrication techniques should be used;
- There should be a provision of facilities to recycle 70% of C&I waste by 2020; and
- Access to waste recovery facilities (anaerobic digestion, pyrolysis/gasification) should be incorporated into the design of the waste management plan to provide a renewable source of energy i.e. methane or hydrogen.

1.30 These requirements have been taken into account when producing this Materials Management Strategy for the NLE.

Mayor's Business Waste Strategy

1.31 The Mayor's Business Waste Management Strategy (Ref. 1-29) sets out the following measures:

- Facilitate business support programmes to clarify the financial and commercial opportunities in applying the waste hierarchy;
- Help business increase access to recycling facilities and reduce barriers to acheiving better waste management;
- Provide strategic investment to encourage new waste infrastructure in London;
- Use the planning process in London to drive resource efficiency improvements in construction and demolition sector.

Mayor's Transport Strategy

1.32 The Mayor's Transport Strategy (MTS) (May 2010) (Ref. 1.40) sets out the transport vision for London over the next 20 years. Proposal 38 relating to the use of the river for moving freight is particular relevant to the construction of the NLE:

> *"The Mayor, through TfL, and working with the Port of London Authority, London boroughs and operators, will seek to ensure that existing safeguarded wharves are fully utilised for waterborne freight (including waste), and will examine the potential to increase the use of the Thames and London's canal network for waterborne freight transport."*

1.33 In summary the MTS looks to promote the efficient movement of people and materials in and around London. A key part of the MTS is to encourage the use of other modes of transport other than the car for the movement of people and materials in and around London.

Local Planning Policy

London Borough of Wandsworth

1.34 The London Borough of Wandsworth (LBW) adopted its Local Development Framework (LDF) Core Strategy in October 2010 (Ref. 1-30). Part of **Core Policy PL9 - River Thames and the Riverside** promotes the beneficial use of the River Thames and states:

> *"wharves will continue to be safeguarded for the transhipment of freight, including waste and aggregates, and for freight related activities."*

1.35 On a similar theme, part of **Core Policy IS1 – Sustainable Development** states:

> *"The movement of freight, waste and other bulk material by water or rail will be encouraged where practical and the retention of rail and water freight facilities supported."*

1.36 Part of **Core Policy IS4 - Protecting and Enhancing Environmental Quality** states:

> *"The Council will support measures to protect and enhance the environmental quality of the borough and work with partner agencies to help deliver this. In particular measures will be taken to:… Ensure development is safe regarding the re-use of contaminated land, in relation to proposals involving hazardous processes and materials and development located close to hazardous installations."*

London Borough of Lambeth

1.37 The London Borough of Lambeth (LBL) adopted its LDF Core Strategy in January 2011 (Ref. 1-31). At this stage, a draft of the Development Management Plan Documents is not available for review but it is anticipated that these will be adopted prior to the TWAs submission. The Lambeth Unitary Development Plan 2007: Policies saved beyond 5 August 2010 (Ref. 1-29) also forms part of the development plan for the area.

1.38 **Policy S7 – Sustainable Design and Construction** states:

> *"Setting Lambeth specific targets on environmental performance including through nationally recognised sustainable building standards; encouraging the re-use of buildings and building materials…provision for sustainable waste management…More specific targets will be set out in the Development Management DPD and detailed guidance will be provided in a Supplementary Planning Document."*

1.39 **Policy S8 – Sustainable Waste Management** states that Lambeth Council will contribute to the sustainable management of waste by:

> *"Supporting the approach to drive waste management up the waste hierarchy in accordance with national policy and regional policy and targets, and in particular the efficient use of resources, the reuse of materials and resources, and the recovery of energy from materials."*

1.40 Saved **Policy 35 – Sustainable Design and Construction** from the Lambeth Unitary Development Plan 2007: Policies saved beyond 5 August 2010, states that all development proposals should incorporate sustainable design and construction principles, including:

> *"Making adequate, integrally-designed provision for the storage and recycling of waste; and…Reducing the use of finite, primary minerals and aggregates and encouraging the maximum use of reused or recycled materials in the building process."*

B1 Materials Management Strategy

London Borough of Southwark

1.41 Prior to the implementation of the Core Strategy (described in the following paragraph), the Southwark Plan (Ref. 1-32) was the statutory development framework for the Borough. Until all the Development Plan Documents (DPD) are adopted there are a number of saved policies within the Southwark Plan that will still be used to inform planning decisions. With respect to waste management this includes **Policy 3.7 – Waste Reduction**. This policy states:

> *"All developments are required to ensure adequate provision of recycling, composting and residual waste disposal, collection and storage facilities. The design of waste and recycling facilities must be easily and safely accessible, improving local amenity. To demonstrate how the waste management hierarchy will be applied during construction and after the development is completed, the council will require major development proposals to be supported by a sustainability assessment….contributing to meeting the objectives of the Council's Waste Management Strategy and regional and national targets for waste management."*

London Borough of Southwark: Core Strategy (2011)

1.42 The Core Strategy (Ref. 1-33) is part of the Development Plan along with the saved Southwark Plan and London Plan. The Core Strategy was adopted in April 2011 and sets out how Southwark will change up to 2026.

1.43 **Strategic Policy 13 – High Environmental Standards** states the following:

> *"Development will help us live and work in a way that respects the limits of the planet's natural resources, reduces pollution and damage to the environment and helps us adapt to climate change. We will do this by:…Increasing recycling and composting, minimising waste, reducing landfill and making more use of waste as a resource…We are aiming to meet the Mayor's target of recycling or reusing 95% of construction, excavation and demolition waste by 2020...Requiring applicants to demonstrate how they will avoid waste and minimise landfill from construction and use of a development."*

London Borough of Southwark Waste Management Strategy 2003-2021

1.44 The Waste Management Strategy 2003-2021 (Ref.1-34) established a commitment to manage waste in a manner that minimises environmental impact and the need to transport wastes and materials.

1.45 The strategic approach to the management of waste within the strategy is based on the following principles:

- *"To reduce total waste arising through the promotion of waste minimisation;*
- *To recover value from waste materials that would otherwise be disposed of in landfill; and*
- *To minimise the social, environmental and financial impacts of waste management."*

London Borough of Southwark: Supplementary Planning Documents (2009)

1.46 The LBS Supplementary Planning Document (SPD) on Sustainable Design and Construction (2009) (Ref. 1-35) supports the policies in the Core Strategy and the London Plan to reduce the amount of waste being created and ending up in landfill and requires 95% of all construction, demolition and excavation waste to be reused or recycled.

1.47 The LBS Supplementary Planning Document (SPD) on Sustainable Assessment (Ref. 1-36) provides guidance on how to carry out a sustainability assessment of planning applications. It sets out how new development will be assessed for sustainability. In particular it provides a checklist which should be completed and submitted with planning applications, minimum standards which proposals will be expected to meet, as well as preferred standards, and guidance on what evidence needs to be submitted along with the checklist.

1.48 Waste Management is included within the checklist and requires information to be submitted on how the proposals will minimise the materials needed in construction and the amount of demolition, excavation and construction waste sent to landfill.

Material Types Generated by the Northern Line Extension

1.49 Table1-2 shows the significant materials streams that are anticipated to arise from the construction of the NLE. Each of these categories is considered in more detail below.

Table 1–2 Significant Materials Streams Anticipated to Arise from Construction of the NLE

Source of Surplus Material	Material Type
Demolition	Brickwork, Glass and ceramics
	Concrete and asphalt
	Steel
	Timber
	Other, including vegetation, cables, etc.
Excavation	Made Ground
	Terrace Gravels
	London Clay
	Harwich Formation (sandy gravelly clay)
	Lambeth Group
	Thanet Sands
	Dredged materials
	Groundwater from excavation seepage
	Contaminated excavated materials
Construction	Surplus and damaged construction materials
	Packaging waste
	Canteen waste
	Hazardous materials (e.g. from refuelling activities)
	Sprayed concrete lining materials

Source of Surplus Material	Material Type
	Pre-cast concrete
	Grout
	Material for the Step Plate Junction

Demolition

1.50 Demolition materials will arise from the following activities:

- Demolition of Kennington Park Lodge at Kennington Park;
- Demolition of section of brick wall at the Beefeater Distillery at Kennington Green;
- Demolition of the following buildings at Nine Elms Station:
  - Banham Security building;
  - New Covent Garden owned office block;
  - Part of car park for Sainsbury's superstore;
  - Incinerator/boiler house;
  - Underground oil tank;
  - Electrical sub-station.
- Removal of advertising hording at Battersea Station.

1.51 The types of materials anticipated to be generated from the demolition are listed in Table 1-2.

Excavation

'Clean' Material

1.52 'Clean' excavated material will arise from the construction of:

- Station boxes at Nine Elms and Battersea;
- Overrun Tunnels at Battersea;
- Crossover at Battersea;
- Running Tunnels;
- Permanent Shafts
- Cross Passages; and
- Either temporary shafts or gallery tunnels (depending on the construction option selected).

1.53 The types of materials anticipated to be generated from the excavation associated with the NLE are listed in Table 1-2.

Contaminated Material

1.54 *Chapter 13: Land Quality and Groundwater* of this ES describes in detail the potential to encounter contaminated material during the construction of the NLE.

1.55 The potential for on-site soil and groundwater contamination has been based on a review of the land-use history at the grouting and venting construction sites, the proposed new stations associated with the NLE and the general area through which the running tunnels are to be constructed.

1.56 It is assumed that the running tunnels, overrun tunnels, cross passages and step plate junctions are deep enough not to encounter any contamination.

1.57 It is assumed that the temporary and permanent ventilation shafts are located where they do not encounter any contaminated soil. A review of the permanent and temporary shaft sites going back to the 1770s has been carried out and it is assumed that contaminated soil would not be present in these locations.

Groundwater

1.58 Groundwater control will take place at the temporary shafts and station boxes. Quantities of groundwater have not been calculated. It is assumed that the groundwater from the station boxes is likely to be contaminated, due to the previous uses of the sites. The groundwater from the temporary shaft locations is likely to be uncontaminated. Licences for disposal of groundwater will be obtained.

Dredging

1.59 A section of riverbed (approximately 150m x 50m x up to 1m deep) in front of the existing Battersea pier will need to be dredged to allow sufficient space for the barges accessing the pier. This is expected to result in approximately 4500m3 dredged material, which is likely to be contaminated due to the historical use of the river at this site. As with the other contaminated material, this will be sent to a suitable site for disposal, either in a segregated barge (i.e. separate from the barges removing other excavated material) or by lorry.

Construction

Construction Materials

1.60 The amount of construction materials will be is shown in Table 1-3.

Table 1-3 Estimated Quantities of the Major Construction Materials

Site	Material Type	Quantity
Running Tunnels and Cross Passages (including Battersea works)	Concrete	99625m^3
	SCL	2365m^3 (incl. in concrete volume above)
	230mm thick precast platform deck units	1695m^2 (incl. in concrete volume above)
	Reinforcement	21740 tonnes
	Grout	14690m^3
	Precast concrete (PCC) lining rings	33985 no.
	Spheroidal Graphite Iron (SGI) lining rings	775 no.
Nine Elms Station	Concrete	74172m^3
	Reinforcement	16445 tonnes

Site	Material Type	Quantity
Kennington Green Vent Shaft	Concrete	2595m^3
	Reinforcement	455 tonnes
	Grout	370m^3
	PCC lining rings	415 no.
Kennington Park Vent Shaft	Concrete	4838m^3
	Reinforcement	1025 tonnes
	Grout	370m^3
	PCC lining rings	415 no.
Temporary Shafts (Option A only)	Concrete	221m^3
	Reinforcement	28 tonnes
	Grout	484m^3
	PCC lining segments	57 no.
	SGI lining segments	256 no.
Step Plate Junctions	Concrete	2140m^3
	Reinforcement	169 tonnes
	Grout	1534m^3
	PCC lining segments	614 no.
	SGI lining segments	3077 no.

Construction Waste

1.61 Common waste streams generated by construction sites and likely to be generated by the NLE include:

- Surplus construction materials as a result of over ordering;
- Bentonite for diaphragm wall construction;
- Materials damaged on site or in transit;
- Hazardous waste, e.g. from refuelling activities and plant maintenance;
- Packaging Materials; and
- Canteen and accommodation waste.

1.62 The most significant potential waste stream generated from the construction of the NLE is the sprayed concrete lining (SCL) material.

Sprayed Concrete Lining Material

1.63 During subsurface construction works SCL will be used for some tunnel sections and cross passages.

1.64 The technique of SCL involves the excavation of tunnels and other structures in stages. At each stage the excavated face is sealed with a thin layer of sprayed concrete for temporary support and then the circumference is sprayed with a thicker primary and/or permanent secondary lining. The temporary face support layer is then excavated to progress the tunnel construction and the process is repeated.

1.65 Waste produced during the process will be generated by face sealing and subsequent excavation, sprayed concrete rebound (consisting mostly of aggregate) and other activities including cleaning of equipment and line and pump losses.

1.66 Rebound and other waste SCL is assumed to account for 30% of the sprayed concrete used in construction. The SCL waste will be mixed with some excavated material at construction sites where it is used. The SCL will comprise mainly concrete containing certain additives and possibly steel fibres added for structural stability and polypropylene fibres added for fire resistance.

1.67 The SCL waste is considered to be non-hazardous waste, rather than inert and is, therefore, identified as a separate category to the clean excavated material.

Quantities of Materials Generated by the Northern Line Extension

1.68 The construction of the NLE is likely to generate large quantities of surplus material. The anticipated breakdown of surplus excavated materials is provided in Table 1-4 for each Construction Option.

Table 1–4 Clean Excavated Material Generated by the NLE

	Construction Option A	Construction Option B
Works	**As dug Volume of Excavated Material (m^3)**	**As dug Volume of Excavated Material (m^3)**
Nine Elms Station Box	110310	110310
Battersea Station Box	76340	76340
Overrun Tunnels and Platform Tunnels at Battersea	12170	12170
Crossover at Battersea	71200	71200
Running Tunnels	141730	141730 (of which 5520 transported by road)
Step Plate Junctions	9030	9030
Kennington Park (Permanent Shaft) and Substation	12500	12500
Kennington Green (Permanent Shaft)	6730	6730
Cross Passages	2160	2160
Temporary Shafts	1300	0
Gallery Tunnels	0	6290

	Construction Option A	Construction Option B
Works	**As dug Volume of Excavated Material (m^3)**	**As dug Volume of Excavated Material (m^3)**
Total	**443470**	**448460**

1.69 Table 1-5 provides an estimate of the other surplus material associated with demolition and excavation. Please note that this will be the same for both Construction Options due to the same amount of demolition and the assumption that this area will have insignificant quantities of contaminated material.

Table 1–5 Other Surplus Material Generated by the NLE (Applies to both Construction Options)

Works	Volume of Materials (m^3)
Demolition Material:	
Brickwork	1400
Concrete and asphalt	1900
Steel	100 tonnes
Timber	600
Other	1200
Contaminated Excavated Material (including made ground)	4670

Management of Materials Generated by the Northern Line Extension

The Waste Hierarchy

1.70 This Waste Management Strategy follows the hierarchy for sustainable waste management as described in the Waste Framework Directive. The hierarchy states that the most favoured option is for the prevention of waste production and the least favoured option is disposal of waste to landfill.

Prevention

1.71 The nature of the works associated with the construction of the NLE particularly the excavation of the tunnels, shafts and station boxes and the demolition of the buildings mean that it is not possible to prevent waste materials from arising altogether.

1.72 The evolution of the NLE's design has sought to minimise the material arisings from demolition (by locating the stations in areas where no demolition is required) and construction (through routing the tunnels in the optimally shortest route and keeping the dimensions of the excavated parts to minimum standards). In addition to this, the following aspects were adopted:

- Nine Elms station crossover and associated temporary shaft deleted due to TfL operational considerations;
- Step plate junction minimises excavation and lining compared to SCL alternative design;
- Retaining Battersea Dogs and Cats Home instead of demolishing and rebuilding it;
- Coordinating with over site developments (OSD) to share facilities (such as muck pile & conveyor) and structures (e.g. foundations);
- Using precast tunnel lining for the majority of the route (which creates less waste than SCL).

1.73 Despite this, as described in Table 1-4 a significant quantity of excavated material will be produced.

Reuse, Recycling and Recovery

1.74 The preferred option for the management of surplus material is to reuse as much of this as possible.

1.75 The works contracts for the NLE will set stringent requirements on Contractors to minimise the waste from construction activities.

1.76 As described in the draft Code of Construction Practice (CoCP), the Contractor will be required to produce an Environmental Management Plan (EMP) in which he will describe the procedures that are in place to ensure that the all parties involved with the management of the waste generated from the site comply with the Waste (England and Wales) Regulations 2011. The CoCP also sets out the waste hierarchy, and that the reuse of materials onsite is preferable to its reuse off site. The Contractor will also produce SWMP in accordance with the Site Waste Management Plan Regulations 2008 (Ref. 1-1).

1.77 The reuse of surplus materials either on or offsite will be subject to the material being tested and deemed suitable for its intended use and will be carried out under the CL:AIRE Protocol or in accordance with the Environmental Permitting Regulations 2012 where applicable.

1.78 The majority of material that is suitable for reuse offsite will be exported by barge (a small proportion will be transported by road) to a trans-shipment facility assumed to be at Northfleet where the material will be loaded onto sea going vessels to allow it to be transported to a pre-identified receptor site (such as the nature reserve at Wallasea Island). Transportation is discussed in more detail later in this Strategy.

Disposal

1.79 Material that is deemed unsuitable for reuse either onsite or offsite and is not suitable for processing via a materials recycling facility (MRF) will be disposed of to landfill (although it is possible that waste could be used in heat recovery before landfill). The amount of material anticipated to be sent to landfill accounts for a very small amount of the total. Other than physical segregation of materials at the point of excavation, it is not proposed to undertake any additional onsite treatment of contaminated soils or dredged materials (although it is possible that contamination could be treated off site). This is due to space and programme constraints and the range and type of contaminants, which are unlikely to require more than one treatment method. Treatment of this type would also be very

costly. Treatment or recovery off-site will be considered in order to reduce any hazardous waste produced as far as possible.

1.80 Details are provided below of the waste management options for following phases of the construction of the NLE:

- Demolition
- Excavation ('Clean' and Contaminated Material)
- Construction (including SCL material)

Demolition

1.81 During the demolition phase, the Contractor will be required to implement the Waste and Resources Action Programme (WRAP) Demolition Best Practice Code (Ref. 1-37), including the ICE Demolition Protocol. (Ref. 1-38).

1.82 Waste from the demolition and enabling works will be subject to onsite screening and sorting in accordance with the Contractor's EMP. This will then be managed in accordance with the national waste hierarchy described above.

1.83 Contractors will be required to follow best practice guidance (as described in the 'Policy and Guidance' section) to ensure that measures to reuse and or recycle waste from the demolition and enabling works are implemented.

1.84 In particular, opportunities for the reuse of demolition material onsite (for example reusing clean demolition material for the construction of temporary haul roads or reusing bricks) should be investigated. This would be preferable to re-using the material off site.

1.85 Contractors will be required to identify local sites that are either licensed or exempt from licensing, to accept, process and recycle demolition materials that cannot be reused on site. It is anticipated that the majority of the materials will be delivered to these sites by road.

Excavation

'Clean' Excavated Material

1.86 Where possible the most preferable option is for Contractors to reuse clean excavated material onsite. However due to the nature of the NLE works there will be a surplus of excavated material which cannot be utilised in this way.

1.87 In terms of re-using this material off site, a study will be carried out to identify whether there are any construction sites local to the NLE works that require the types of material being generated by the project. The majority of the excavated material will be 'clean' London Clay, this is suitable for the engineering of ground works and landscape projects. One such project that has been identified as a potential receptor site for the reuse of the excavated material from the NLE is the construction of a nature reserve at Wallasea Island. At the time of writing it has not been confirmed as to whether the Wallasea Island project can accept the material generated by the NLE. However, should the excavated material be acceptable for reuse at Wallasea Island, such material will be transported to the Dockland and Northfleet trans-shipment facility. This facility is located approximately 35km to the east of Battersea Power Station, along the north Kent coast, and will be used to further transport the excavated material of the NLE to Wallasea Island (via sea going barges).

1.88 To reduce the potential for environmental impacts associated with transportation of waste (e.g. fuel use and emissions to air such as carbon dioxide, nitrogen dioxide and particulate matter) Contractors will be required to identify receptor sites that are as close to the site of the generation of waste as possible, preferably within the Greater London area. Additionally where practicable materials will be transported via barge (this is described in more detail in the transportation section below).

1.89 The Contractor and TfL will liaise with the Environment Agency, the planning authorities and the development agencies in London and the south-east of England in order to identify the most beneficial opportunities for the re-use of excavated materials.

1.90 It is not deemed practicable to carry out onsite treatment of mixed excavated materials that are deemed unsuitable for reuse in their current state (e.g. aggregates mixed with soils). This is due to constraints onsite such as space (the equipment associated with screening and grading together with areas for storage of materials onsite would require further land take). The grading and screening of materials on site would also contribute to an increase in noise and dust effects from the construction site.

1.91 The Contractor will be required to identify a licensed facility that can accept and treat mixed excavated materials where practicable. Several licensed commercial waste companies operate in London and the south east. Such companies treat this material and sell it on for reuse thus diverting it from landfill. Additionally there are sites that are exempt from licensing as they require materials for site restoration and development.

Contaminated Excavated Material

1.92 As stated in *Chapter 13: Land Quality and Groundwater* of this ES, it is unlikely that large quantities of contaminated material will be encountered during the construction of the NLE.

1.93 However, where there is potential for contaminated land to be encountered (e.g due to previous land use) as identified in *Chapter 13: Land Quality and Groundwater* of this ES provision will be made in the construction programme for intrusive investigations to be carried out. The results of these investigations will determine the nature and extent of the contamination and allow for classification under the Consolidated European Waste Catalogue, and application of the CL:AIRE protocol.

1.94 Where contamination is known to be present, the Contractor will be required to carry out a risk assessment to identify whether the works associated with the NLE will create a 'Source – Pathway – Receptor' linkage and lead to the mobilisation of contaminants. Where the risk assessment concludes that the contaminated material would not be mobilised the best practicable solution would be to leave the material in situ.

1.95 Where it is identified that the construction works would result in the mobilisation of contaminants action would be required to avoid harm to human health or the environment. Such action could include:

- Containment;
- Treatment onsite;
- Treatment offsite; and
- Disposal to a licenced landfill site (remediation may be required prior to disposal depending on the nature of contamination present).

1.96 Containment of contaminated materials is a suitable form of mitigation when pollutants have been identified that have the potential to migrate into the groundwater or be

released to atmosphere. The Contractor will identify whether this is a suitable mitigation and chose an appropriate form of containment (options include the use of a concrete overlay or engineered bentonite cells).

1.97 Where containment is not possible, the best practicable environmental option (BPEO) would be for remediation of contaminated material and the subsequent reuse of this material onsite. However due to the constraints associated with these techniques which require space on site for equipment and the stock piling of materials and the time taken to remediate the material into a 'clean' state this is not considered to be a viable option. Remediation would require additional land take and impact on the timely delivery of the NLE.

1.98 Offsite commercial treatment facilities exist and the Contractor will identify such a location if there is a requirement to remediate contaminated waste.

1.99 EU Waste Acceptance Criteria (WAC) are in place to control the nature of hazardous waste that can be sent to landfill. For hazardous wastes there are numerical limit values covering substances in granular wastes, monolithic wastes, and stable non-reactive hazardous wastes (SNRHW). (Ref. 1-39). The limit values are set out in the Landfill (England and Wales)(Amendment) Regulations 2004 and the Landfill (England and Wales)(Amendment) Regulations 2005.

1.100 If contaminated material is encountered during the works this will be managed in accordance with the relevant health and safety and waste legislation.

Construction

1.101 Contractors will be required to be registered with the Considerate Constructors Scheme and will be expected to minimise waste production where practicable and manage waste in accordance with best practice and the relevant legislation.

1.102 The CoCP and the Contractor's EMP and SWMP will describe the procedures to manage waste on site. These procedures should ensure that facilities for the segregation of waste and recycling are easily accessible and that the following opportunities to minimise and reduce waste generation are considered:

- Agreements with material suppliers to reduce the amount of packaging or to participate in a packaging take back scheme;
- Implementation of a 'just in time' material delivery system to avoid materials being stockpiled on-site for long periods of time, which increases the risk of their damage and disposal as waste;
- Use of prefabricated materials to minimise waste on site;
- Attention to material quantity requirements to avoid over ordering and generation of wasted materials;
- Reuse of materials on-site wherever feasible,
- Segregation of waste at source where practical; and
- Reuse and recycling of materials off-site where reuse on-site is not practical (e.g. through use of an off-site waste segregation facility and re-sale for direct reuse or reprocessing).

1.103 The Contractor will ensure that the disposal of all waste or other materials removed from the Site is in accordance with the requirements of the Environment Agency, Control of Pollution Act, 1974 (COPA), Environmental Act, 1995, Hazardous Waste Regulations, 2005 and the Waste (England and Wales) Regulations 2011.

1.104 SCL contaminated material is categorized as non-hazardous waste and will need to be assigned to a site that can accept such material. It is possible that SCL material could be crushed for secondary aggregate before being sent for disposal.

Transportation of Material Generated by the NLE

1.105 The options for the transportation of surplus materials from the NLE are influenced by the position and availability of transhipment and receiving sites; the availability of land for stockpiling materials; the requirement for infrastructure changes, the location of receptor sites and the availability of waterways.

1.106 Under Option A and Option B an estimated 70% and 68% (by volume) respectively of material will be removed by barge, with the remainder by road. A description of each of these transportation methods is provided below.

Removal by Barge

1.107 Removal of surplus material via the River Thames provides a viable and sustainable mode of transport. Barges offer a large capacity for bulk transport (i.e. 1000 tonnes per barge) when compared with an average lorry load (20 tonnes). This results in a much lower amount of movements than would be required for road transport and avoids the contribution of traffic to London's road network and associated air quality effects (see *Chapter 10: Air Quality* of this ES).

1.108 The excavated material is to be removed from the tunnel entrance via an inclined conveyor into an inverted hopper. Material will then be transported via a series of conveyors to the jetty, where it will be loaded into barges at a two berth facility at the Battersea Power Station jetty.

Stockpile

1.109 A stockpile will be required at the Battersea Power Station site. An assessment has been made to estimate the size of the stockpile required to allow adequate storage to enable the efficient loading to capacity of barges every trip without requiring additional land take at the site. The stockpile size is also calculated as a contingency on barges not arriving due to poor weather conditions, river obstruction or barrier closure. Please refer to the mitigation measures in *Chapter 10: Air Quality* of this ES on how the stockpiles will be managed e.g. to prevent the generation of dust.

1.110 Excavated material was calculated in cubic metres. The in-situ density of material used was 2, i.e. $1m^3$ of excavated material has a mass of 2 tonnes. This factor was used in calculating the amount of material that could be removed by barge. The bulking factor used was also 2, and this was used in calculating the stockpile size.

1.111 For the station box, over-run tunnels and crossing box, the amount of excavated material was divided by the number of weeks in the Construction Option A programme and a six day working week, to give a daily output amount.

1.112 Each of the running tunnels is to be dug by TBM; as such, the rate of advance of the machine drives the daily excavation amount. An advance rate of 13m per 12-hour shift was assumed, with two shifts per day and a six day working week (to allow one day for maintenance per week). The amount of material was divided by this rate to give the expected number of weeks. The daily excavation amounts were aligned with the construction option A design programme and this was used to calculate total peak daily and weekly excavation amounts.

Stockpile Requirements

1.113 Peak excavation amount occurs when both TBMs are running simultaneously, along with excavations for the station box being carried out. This gives a daily output rate of approximately 1500m^3 as dug.

1.114 Two barges on two high tides per 25 hours can clear 3840 tonnes (1920m^3) per day, meaning that all of the excavated material from the tunnels will be cleared in a normal day, without the need to stockpile any arisings. However, there are a number of reasons that the barges may not be available every high tide, and this is the reason space for a stockpile is required within the worksite.

1.115 One reason is due to closures of the Thames Barrier. This is closed every month for maintenance and testing for approximately two and a half hours, just after low tide, and as required to prevent tidal surges. In these cases the barrier is closed at low tide and remains closed until after the following high tide. This could prevent one pair of barges from reaching the jetty for loading; and as it is sometimes necessary to close the barrier on a number of successive high tides, a decision was taken to allow for three days of accumulation of excavated material.

1.116 Three days worth of stockpile at the peak of excavation equates to 3 x 1500m^3, or approximately 4500m^3 as dug. It is assumed that any closure occurs in the first week that both TBMs are running, with excavations for the station box on-going.

Stockpile Shape and Maximum Size

1.117 The stockpile is to be retained up to 1m using precast 'L' shaped cantilever concrete retaining walls. It will then be sloped at 1:2 up to a height of 3m. An 8m wide berm will run around two sides of this, followed by two more 3m high layers sloped at 1:2 with an 8m berm between. It is expected that a 1:2 slope can be achieved for London Clay.

1.118 The 8m wide berm allows an excavator and a truck to pass one another whilst moving the excavated material between the stockpile and the inverted hopper. It is assumed that the excavator will remain on the stockpile, with trucks being used to transfer the excavated material between the stockpile and the inverted hopper at the start of the conveyor run. It is not expected that the transfer of materials between the stockpile and the inverted hopper is a limiting factor.

Removal by Road

1.119 At those sites where it is not proposed to send material for transport by barge, and where contaminated material is discovered, the material will be transported by road. The amount of lorries arising from each worksite is described in the *Transport Assessment* provided in *Appendix C of ES Volume II* and its impact described in *Chapter 6: Traffic and Transport* of ES Volume I.

Conclusion

1.120 This report has identified a strategy for how the materials generated by the construction of the NLE will be managed. It is apparent that significant quantities of building materials will be required for the NLE. These will mainly comprise concrete (precast and sprayed), metal and grout. This material will be bought to the sites by road and will be handled so as not to cause additional waste. It is also likely that large quantities of surplus material will be generated - the majority of this will be clean excavated material with the potential for a small amount of contaminated material to be present. There will also be materials arising through the demolition of buildings and wastage from construction activities.

1.121 All wastes have an intrinsic value and can harm the environment if not managed carefully, as well as being costly (see Appendix O: Project Sustainability Appraisal Report). TfL are committed to minimising waste, and through following the waste hierarchy, have adopted various measures to divert surplus material from landfill where reasonably practicable and to reduce waste arisings. They are also targeting 95% of all CD&E waste to be reused and recycled. The majority of this material cannot be reused on site, and so it is proposed to transport this (as far as possible) by barge, to a suitable receiving facility, which will reuse the waste received. The measures set out in this report, along with TfL's targets, illustrate the NLE's good practice with regards to sustainable waste management, along with adherence with the relevant legislation and policy. Due to site constraints it is not possible to effectively treat contaminated material on site, and this will either be transported to a treatment facility or disposed of in a licensed landfill.

1.122 TfL will continue to work with local authorities, neighbouring developers and appointed contractors to minimise the impact of the movement of construction material including greater use of the River Thames where practicable.

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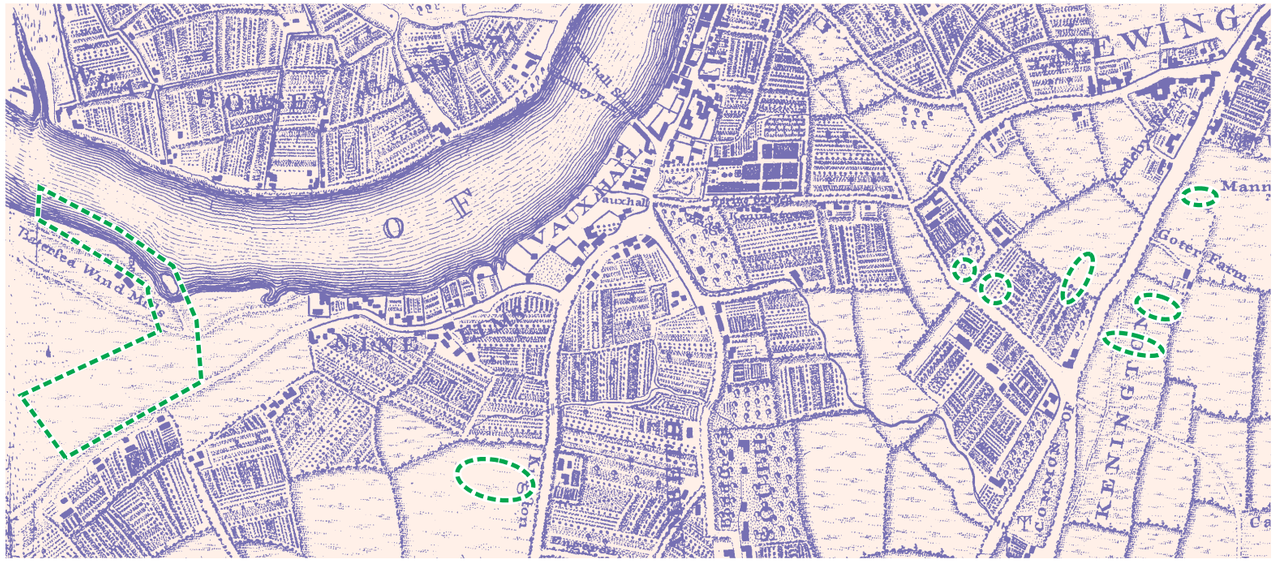
D: Archaeology and Built Heritage

Environmental Statement

Volume II



NORTHERN LINE EXTENSION
Kennington, Nine Elms, Battersea
London

London Boroughs of Wandsworth, Lambeth and Southwark

Historic environment assessment

April 2013

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London Boroughs of Southwark, Lambeth and Wandsworth

An historic environment assessment

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Note: site outlines may appear differently on some figures owing to distortions in historic maps. North is approximate on early maps.

Executive summary

URS Infrastructure and Environment Ltd on behalf of Transport for London has commissioned Museum of London Archaeology to carry out a historic environment assessment in advance of the proposed Northern line extension from Kennington Station via Nine Elms to Battersea. The scheme comprises two new 3km-long underground running tunnels, two new stations (at Nine Elms and Battersea), two access / ventilation shafts and two temporary grouting shaft worksites. The connection (stepplate junctions) between the existing and new running tunnels would be made and reinforced by means of sprayed concrete lining gallery tunnels from the two permanent ventilation shafts or, under an alternative option, the connection would be made using two additional temporary shafts opened from ground level. Both options are considered for this report.

This desk-based study assesses the impact of the proposals on buried heritage assets (archaeological remains) and above ground heritage assets (structures of historic interest), and forms a technical appendix in support of an Environmental Statement.

Heritage assets that may be affected by the proposals comprise:

- ***Battersea station*** *– a low to moderate potential for buried remains of a 19th-century reservoir and associated water works buildings, and the 20th-century railway and depot: parts of associated boundary walls and entrance gates survive above-ground on the southern site perimeter. A proposed conveyor to the existing Thames-side Battersea Power Station jetty access crosses an Archaeological Priority Area covering the Thames riverside, and the cranes on the jetty are included in the Power Station's Grade II* listing. The site has high potential for palaeoenvironmental remains, of medium significance, and moderate potential for remains of riverside structures and preserved waterlogged organic remains, potentially of medium to high significance. There is a low potential for buried remains of other periods.*
- ***Nine Elms station*** *– immediately adjacent to an Archaeological Priority Area covering the Thames riverside and the ancient Battersea Channel, into which works may extend. The western part of the site has a low to moderate potential to contain buried prehistoric remains (with supporting palaeoenvironmental evidence) preserved in waterlogged conditions. The eastern part of the site has a generally low potential for buried remains of the prehistoric to medieval periods. The existing mid 19th-century and 20th-century industrial buildings at the site would be demolished. Further buried structural evidence of industrial archaeology and 19th-century houses might survive.*
- ***Kennington Green permanent shaft and headhouse, with a water tank to the west on Montford Place*** *– within a local authority Conservation Area, and Kennington Green is designated under the London Squares Preservation Act, 1931. On the proposed site of the headhouse there is high potential for buried remains of a 20th-century gas works and possibly moderate potential for buried remains of late-18th-century houses, and for buried remains of mid-19th century houses on the water tank site. Both sites have an uncertain, probably low, potential for prehistoric to medieval remains.*
- ***Kennington Park permanent shaft and headhouse / traction sub-station*** *– within a Conservation Area and within Kennington Park (a Grade II Registered Park). There is uncertain, probably low, potential for buried prehistoric to post-medieval remains. The works would demolish a* ***20th century lodge*** *of limited heritage interest.*
- ***Radcot Street temporary grouting shaft and worksite*** *– within a Conservation Area. There is low potential for buried remains of the prehistoric to post-medieval periods.*

- ***Harmsworth Street temporary grouting shaft and worksite*** *– a low potential for buried remains of the prehistoric to post-medieval periods.*
- ***Kennington underground station*** *– the construction of new platform-level cross-passages at the Grade II listed station would alter the fabric although the effect of the impact may be limited. Listed building consent will be required, and also possible historic building recording to an appropriate level (preservation by record).*

All of the sites will either impact directly on or alter ***the setting of standing buildings*** *of varying degrees of heritage significance. This report assesses only direct physical impacts upon individual buildings: issues such as setting, the collective streetscape, Conservation Area character, views and visual effects, and the impact of noise, worksite massing or construction traffic are considered elsewhere.*

Predicted noise levels of the proposed development would need to be confirmed and updated following further surveys at a more detailed design stage, therefore any physical noise mitigation to Listed and locally listed buildings, such as secondary glazing, will be identified via the necessary notifications to English Heritage and Local Authorities as specified in the Code of Construction Practice.

The railway tunnels would be bored at too deep a level to have an archaeological impact. The impact on archaeological remains would therefore arise from the proposed excavations for the stations, shafts, sub-stations and headhouses, which would remove entirely any archaeological remains, reducing their significance to negligible. Temporary works such as service diversions, works compounds, crane construction, the Battersea conveyor and jetty, and associated dredging, might partially or completely remove archaeological remains, depending upon the depth of ground excavation. Underpinning, new piles and ground settlement compensation for buildings and services along the route liable to damage due to settlement may have an impact on any buried archaeological remains, depending on the depth and extent of such works.

In order to further quantify the actual nature, survival and significance of buried archaeology (and hence inform mitigation strategies) a phase of site-based assessment (archaeological field evaluation) is recommended. This should include the Battersea and Nine Elms station sites and the locations of shafts and associated structures at Kennington Park and Kennington Green, and might include an initial modelling of existing geotechnical data in order to more fully interpret the buried strata and topography. This could in turn determine locations for selective archaeologically- designed trial work, including geoarchaeological boreholes and test pits. Internal inspections of buildings proposed for demolition at the Nine Elms Station site and in Kennington Park, and the location and extent of works at Kennington Station are also recommended to inform the level of any mitigation necessary.

The assessment has not identified any nationally-significant below ground heritage assets directly affected by the development scheme, where permanent protection and retention may be merited (a mitigation strategy of preservation in situ). Where, therefore, the desk and site-based assessments indicate that built or buried heritage assets would be affected by the development scheme, the standard mitigation strategy would be further archaeological investigation and recording of them, prior to and during construction, (a mitigation strategy of preservation by record). If such mitigation is required by the local planning authority it is normally secured by standard planning conditions that require submission of a scope of works for approval (a Written Scheme of Investigation). Mitigation will be described in the Code of Construction Practice in Appendix O.

1 Introduction

1.1 Origin and scope of the report

1.1.1 URS Infrastructure and Environment Ltd (URS) on behalf of Transport for London has commissioned Museum of London Archaeology (MOLA) to carry out a historic environment assessment (HEA) (for a Transport and Works Act Order) of a proposed Northern line extension (NLE) from Kennington Station to Battersea, in the London Boroughs of Southwark, Wandsworth and Lambeth, National Grid Reference (NGR) 531505 178115 to 529060 177275: Fig 1. The scheme comprises two new 3km-long underground running tunnels, two new stations (at Nine Elms and Battersea) and two access / ventilation shafts and associated temporary worksites. The connection (stepplate junctions) between the existing and new running tunnels would be made and reinforced by means of sprayed concrete lining gallery tunnels from the two permanent ventilation shafts or, under an alternative option 2, the connection would be made using two additional temporary shafts opened from ground level. Both options are considered in this report. The construction of new platform-level cross-passages is also proposed at Kennington station.

1.1.2 This desk-based study assesses the impact of the scheme on buried heritage assets (archaeological remains) and above ground heritage assets (upstanding structures): the scope is set out in detail in section 2.1. It forms a technical Appendix in support of an Environmental Statement (ES), assessing the impact of the proposed development on the historic environment in and around the areas hereafter referred to as the 'site' or 'sites'. It will enable the archaeological advisors to the local planning authority (LPA) to formulate an appropriate response in the light of the impact upon any known or possible heritage assets. These are parts of the historic environment which are considered to be significant because of their historic, archaeological, architectural or artistic interest. These might comprise below and above ground archaeological remains, buildings, structures, monuments or heritage landscape within or immediately around the sites.

1.1.3 The assessment has been carried out in accordance with the requirements of the National Planning Policy Framework (NPPF) (DCLG 2012; see section 10 of this report) and to standards specified by the Institute for Archaeologists (IfA 2012), English Heritage (2006, 2007, 2008, 2010), and the Greater London Archaeological Advisory Service (EH 1998, 1999, 2009). Under the 'Copyright, Designs and Patents Act' 1988 MOLA retains the copyright to this document.

1.1.4 Note: within the limitations imposed by dealing with historical material and maps, the information in this document is, to the best knowledge of the authors and MOLA, correct at the time of writing. Further archaeological investigation, more information about the nature of the present buildings, and/or more detailed proposals for redevelopment may require changes to all or parts of the document.

1.2 Project background

1.2.1 The proposed route crosses three London Boroughs (Southwark, Lambeth and Wandsworth) and extends from just south of the existing Kennington Station west/south-west to Battersea.

1.2.2 In addition to the twin running tunnels excavated by two Tunnel Boring Machines (TBMs), two new cut-and-cover underground stations (at Nine Elms and Battersea) and two new ventilation shafts are proposed. These are located near the north-eastern ends of the new running tunnels to allow for removal of the TBMs, and subsequent adequate ventilation and access, with associated headhouse structures and one below-ground sub-station. Two temporary shafts for access may also be excavated close to the location below-ground of the ground stabilisation (grouting) at the connection of the existing and new underground tunnels. Temporary

worksites at each shaft location would also be required for deliveries, storage and general works use. Buildings along the NLE route which would be at risk of moderate or severe damage from the works or associated settlement may require underpinning or other mitigation, with a possible resulting impact on archaeological remains.

1.2.3 The locations of the stations, shafts and worksites are as follows:

- **Battersea station**, Battersea Park Road, NGR 529060 177275;
- **Nine Elms station**, Wandsworth Road / Pascal Street, NGR 529985 177345;
- **Kennington Green permanent ventilation shaft and headhouse**, also for TBM removal, NGR 531210 178015;
- **Radcot Street temporary grouting shaft and worksite**, NGR 531390 178110
- **Kennington Park permanent ventilation shaft and headhouse / traction sub-station**, also for TBM removal, NGR 531540 177925;
- **Harmsworth Street temporary grouting shaft and worksite**, NGR 531541 178033; and
- **Kennington station**, Kennington Park Road, NGR 531635 178285.

1.3 Designated (protected) heritage assets

1.3.1 The NLE route does not fall within the constraint area of any scheduled monuments.

1.3.2 The north-eastern and central sections of the NLE route (northbound and southbound) cross Archaeological Priority Zones (APZs) as designated by the London Boroughs of Southwark and Lambeth, for their archaeological potential in the vicinity of Roman roads and in the area of medieval settlement at South Lambeth. The south-western section of the route (northbound and southbound) and the proposed conveyor route for the construction of Battersea station cross an Archaeological Priority Area (APA) as designated by the London Borough of Wandsworth, for the archaeological and geoarchaeological potential of the Thames riverside, and of the former marshlands, channels and gravel islands south of the Thames.

1.3.3 Kennington Park, the location of the southbound ventilation shaft and headhouse site, is registered under the Historic Buildings and Ancient Monuments Act 1953 within the Register of Historic Parks and Gardens by English Heritage for its special historic interest (Grade II).

1.3.4 Kennington station is Grade II listed. The Battersea station site contains cranes on the Thames-side jetty included in the Grade II* listing of Battersea Power Station. None of the other sites contain listed buildings. All sites except the Nine Elms station site fall within the setting of a listed building (around 50 in total) or of a conservation area. These have been listed in the site-specific worksheets in section 5 below. In terms of impacts, this report assesses only physical impacts onto structures of heritage significance, either directly through demolition, or indirectly as mitigation against other project-wide effects e.g. underpinning to mitigate settlement.

1.4 Aims and objectives

1.4.1 The aim of the assessment is to:

- identify the presence of any known or potential heritage assets that may be affected by the proposals;
- describe the significance of such assets, as required by national planning policy (see section 10 for planning framework and section 11 for methodology used to determine significance);

- assess the likely impacts upon the significance of the assets arising from the proposals; and
- provide recommendations to further assessment where necessary of the historic assets affected, and/or mitigation aimed at reducing or removing completely any adverse impacts upon heritage assets and/or their setting.

2 Scope and methodology

2.1 Scope

2.1.1 The NLE running tunnels would be bored far below the level of anthropogenic strata and would not have an archaeological impact. Only groundworks undertaken at or from current ground level would have a potential impact. This report therefore considers the impact of the proposed shafts and the station box footprints, where all archaeological remains would be removed. Additional associated impacts have also been taken into account, for example; groundworks/excavation for the establishment of works compounds, crane bases, generators and compressors, ventilation plants, storage areas, offices and car parking. Any underpinning or compensation grouting for buildings predicted to be at risk from settlement would also have a potential archaeological impact.

2.1.2 This assessment considers adverse impacts upon built heritage assets of very high to low significance (i.e. Grade I, II*, II listed or locally listed buildings, and non-designated built assets of heritage significance). Although drawing from a wider baseline (see below), the impacts assessment is concerned with those assets which would be either physically impacted on by construction or, for nationally and locally listed buildings only, where they would be impacted on by mitigation against settlement.

2.2 Sources consulted

2.2.1 For the purposes of this report the documentary and cartographic sources, including results from any archaeological investigations in a defined study area around the proposed NLE route were examined in order to determine the likely nature, extent, preservation and significance of any heritage assets that may be present within the sites or their immediate vicinity. This information has been used to determine the potential for previously unrecorded heritage assets of any specific chronological period to be present within the sites.

2.2.2 The primary repositories of archaeological and historical information within Greater London comprise the Greater London Historic Environment Record (GLHER) and the London Archaeological Archive and Research Centre (LAARC). The GLHER is managed by English Heritage and includes information from past investigations, local knowledge, find spots, and documentary and cartographic sources. LAARC includes a public archive of past investigations and is managed by the Museum of London. The study area was considered through professional judgement to be appropriate to characterise the historic environment of the site. Occasionally there may be reference to assets beyond this study area, where appropriate, e.g., where such assets are particularly significant and/or where they contribute to current understanding of the historic environment.

2.2.3 In addition, the following sources were consulted:

- MOLA – Geographical Information System, the deposit survival archive, published historic maps and archaeological publications;
- National Monuments Record (NMR) – information on statutory designations including scheduled monuments and listed buildings;
- The London Society Library – published histories and journals;
- British National Copyright Library – historic Ordnance Survey maps from the first edition (1860–70s) to the present day;
- British Geological Survey (BGS) – solid and drift geology digital map;
- Treasury Holdings – geotechnical data within the Concept Site Investigations report (July 2010), see Appendix 13 of the ES Volume II;

- URS – Ground Settlement Report (Halcrow Group Limited 2013, see Appendix 12); and
- Internet – web-published material including the LPA local plan, and information on conservation areas and locally listed buildings.

2.2.4 The assessment included site visits carried out on the 29th of July 2010, between 13th and 19th of April 2012 and on the 14th of January 2013 and the 28th of February 2013 in order to determine the topography of the sites, existing land use and the nature of the existing buildings around the sites, and to provide further information on areas of possible past ground disturbance and general historic environment potential. Observations made on the site visits have been incorporated into this report. Access to the Battersea station site was not possible, and the ground levels were obscured by spoil mounds. Battersea Dogs and Cats Home kindly gave their permission for the MOLA built heritage specialist to visit the premises to investigate Whittington Lodge.

2.3 Buried heritage assessment methodology

2.3.1 In order to set the sites into their full archaeological and historical context, information was collected on the known historic environment features within a 'study area' extending *c* 250m either side of the proposed route (see Fig 1). The south-west corner is at NGR 528750 177000, and the north-east corner at NGR 531625 178300. The Limits of Deviation of the proposed station boxes, ventilation and construction shafts, considered as 10m around the proposed sites, have been taken into account within this assessment.

2.4 Built heritage assessment methodology

2.4.1 Listed and locally listed buildings were identified along the whole route of the proposed development. In conjunction with the proposal plans, those buildings which would be directly physically impacted on by construction work were assessed for heritage significance and impact assessment with appropriate mitigation suggested (see below).

2.4.2 Of those built heritage assets potentially impacted on by settlement associated with the development, none fell within the upper two levels of magnitude (i.e. moderate and severe) for settlement impact, i.e. those that may require underpinning as mitigation as stated by supplied survey drawings (Halcrow Group Limited, Ground Settlement Report (2013), see Appendix 12). A number of assets fell within the 'slight' level of magnitude, the lowest level potentially requiring settlement mitigation. These have been assessed in this report.

2.4.3 Sites and their surroundings often include buildings, features or structures which – although not designated either nationally or locally – are of heritage significance. In this report, the presence of such heritage assets has been noted for each site, but individual examples have only been further described where they are affected by the proposed development.

2.5 Organisation of this report

2.5.1 Section 4 gives a broad archaeological and historical background for the whole study area. Detailed assessments for the individual sites, including features shown on Ordnance Survey maps and past impacts which may have affected archaeological survival, are in section 5.

2.5.2 Fig 2 shows the location of known historic environment features within the study area. These have been allocated a unique historic environment assessment reference number (**HEA 1, 2**, etc), which is listed in a gazetteer at the back of this report and is referred to in the text. All statutorily listed buildings within the study area are shown. However, only those built heritage assets that will be potentially

impacted upon by the proposed development have been assigned HEA numbers and included in the project gazetteer. All distances quoted in the text are approximate (within 5m).

2.5.3 Section 11 sets out the criteria used to determine the significance of heritage assets. This is based on four values set out in English Heritage's *Conservation principles, policies and guidance* (2008), and comprise evidential, historical, aesthetic and communal value. The statements of significance have been considered under two broad headings: 'above-ground assets' and 'buried assets'. The former are visible and tangible, and thus their significance is more evident. This is not usually the case for buried assets. The report assesses the likely presence of such assets within (and beyond) the sites, factors which may have compromised buried asset survival (i.e. present and previous land use), as well as possible significance.

2.5.4 Section 12 contains a glossary of technical terms. A full bibliography and list of sources consulted may be found in section 14. This section includes non-archaeological constraints and a list of existing site survey data obtained as part of the assessment.

3 Site location, topography and geology

3.1 Site location

3.1.1 The proposed NLE (Fig 1) extends from just south of Kennington Station (NGR 531635 178285) to Battersea (NGR 529060 177275). It falls within the historic parishes of Battersea, Lambeth and Newington, and used to lie within the county of Surrey prior to being absorbed into the administration of the Greater London Boroughs of Wandsworth, Lambeth and Southwark.

3.1.2 The NLE is located to the south of the River Thames. Its western end is *c* 200m south of the modern bank of the River Thames, and the eastern end is located *c* 1km east of the river.

3.2 Topography

3.2.1 Topography can provide an indication of suitability for early settlement, and ground levels may show whether the ground has been built up or truncated, which can have implications for archaeological survival.

3.2.2 Ground level at the western end of the proposed route lies at *c* 6.0m above Ordnance Datum (OD), falling to *c* 3.0m OD in the centre of the route, and then levelling out to *c* 3.5m OD at the eastern end of the route.

3.3 Geology

3.3.1 Geology can also be an indicator of suitability for early settlement, and of the potential depth and thickness of archaeological remains.

3.3.2 The geology of the study area comprises Thames Gravels, overlaid by deep alluvium in the western part, which marks the location of a palaeochannel, a broad buried former tributary of the Thames, known as the Battersea Channel (Fig 2). The Battersea Channel is significant enough in size to have once been an important landscape feature, probably during much of prehistory. It has been shown by pollen evidence to have been active from the final stages of the last glaciation, possibly as long ago as full Devensian (last ice age; *c* 20,000–15,000 years ago), and at least as old as the Younger Dryas (final cold phase; *c* 11,000–10,000 years ago) (Morley 2009, 175).

3.3.3 Geoarchaeological borehole work carried out at 102–104 Stewarts Road, outside the study area *c* 730m to the south-east of the proposed Battersea station site, has shown that this channel flowed at least until the mid Mesolithic, *c* 7,500 years ago (Morley 2009), when oak, elm and lime dominated the woodland species, and a marshy carr-dominated landscape predominated in channel proximal areas. The base of this channel was found to lie at *c* –3.0m OD, with at least 2m of late glacial and early Holocene (Mesolithic) sediments infilling it. Peat levels dated to the mid-Mesolithic were observed in the channel at *c* –1.25m OD to –1.75m OD. Peat, representing the rotted vegetation of a former land surface, would have formed as the channel silted up or migrated laterally. The upper part of this sequence had been subject to modern truncation at roughly 1.0m OD to –1.0m OD. The channel and its marginal wetland areas would have been conducive to the preservation of organic archaeological material (e.g. boats, textiles, wooden implements), and also for the preservation of palaeoenvironmental remains such as seeds, nuts and plant macrofossils.

3.3.4 The channel separates two areas of higher gravel, the Kempton Park Gravel terrace to the east and an island of Kempton Park gravel to the west. Such islands are known as ‘eyots’, and are thought to relate to remnants of former courses of the River Thames, as it flowed across the area around 30,000 to 150,000 years ago. The higher gravel island to the west is generally referred to as the Battersea eyot

(Morley, 2009).

3.3.5 A series of test pits and boreholes were excavated and archaeologically monitored in 2008 in the area of Ponton Road (**HEA 1**), *c* 100m to the north of the eastern section of the NLE route to the north-west of the proposed Nine Elms station. The top of natural gravel was recorded at *c* 1.0m OD, overlain in most areas by alluvial clay to *c* 1.25–2.0m OD. At this high level the gravel is likely to have formed a localised gravel eyot or island in the channel and probably remained dry until the Roman period, when rising water levels would have caused it to be seasonally flooded. The south-western end of the proposed route, including Battersea station, lies on such an area of high, drier ground which would have been very attractive in the prehistoric period, with a dependable water supply, and suitable for subsistence activities (e.g. hunting and fishing) possibly with associated occupation and domestic activity. Between the proposed Nine Elms and Battersea stations is an area probably of deeper subsurface gravels of the Battersea Channel with the potential for waterlogged archaeological remains. One borehole at the western part of the proposed route recorded gravel at –3.6m OD, overlain by a mixed deposit interpreted as the fill of a deeply-cut feature, possibly a palaeochannel (Concept Site Investigations 2008).

3.3.6 The area east of the proposed Nine Elms station lies on gravels of the Kempton Park Terrace, which was most likely incised and bisected during the late Pleistocene when the Shepperton Gravel was laid down within the braided channels of the Late Glacial Thames.

3.3.7 In April and May 2010, 10 Cable percussion boreholes (BH01–BH10, see Fig 13) were drilled for engineering purposes at locations along the proposed route (see Appendix 15). These indicated that the anticipated levels of the natural geology would be the top of the alluvium between 4.6m OD and −0.75m OD, with Terrace Gravels between 4.1m OD and –1.95m OD.

4 Archaeological and historical background

4.1 Overview of past investigations

4.1.1 There have been a number of past archaeological investigations across the study area. Most have been limited in scale, and have largely found evidence of the natural topography, and of post-medieval activity and truncation.

4.1.2 The results of these investigations, along with other known sites and finds within the study area, are discussed by period, below. The date ranges given are approximate.

4.2 Chronological summary

Prehistoric period (700,000 BC–AD 43)

4.2.1 The Lower (700,000–250,000 BC) and Middle (250,000–40,000 BC) Palaeolithic saw alternating warm and cold phases and intermittent perhaps seasonal occupation. During the Upper Palaeolithic (40,000–10,000 BC), after the last glacial maximum, and in particular after around 13,000 BC, further climate warming took place and the environment changed from steppe-tundra to birch and pine woodland. It is probably at this time that Britain first saw continuous occupation. Erosion has removed much of the Palaeolithic land surfaces and finds are typically residual. There are no known finds dated to this period within the study area.

4.2.2 The Mesolithic hunter-gather communities of the postglacial period (10,000–4000 BC) inhabited a still largely wooded environment. In terms of floodplain geomorphology the area would have been a highly dynamic, evolving landscape, with the Thames floodplain especially favoured in providing a reliable source of food and other resources. The river was also a means of transport and communication. Evidence of activity is characterised by flint tools rather than structural remains. The GLHER includes a possibly Mesolithic or Neolithic stone axe found by chance close to the Battersea station site at the Southwark and Vauxhall Water Works (**HEA 57**) in 1889, where the presence of a higher gravel eyot might have been a focus for activity.

4.2.3 The Neolithic (4000–2000 BC), Bronze Age (2000–600 BC) and Iron Age (600 BC–AD 43) are traditionally seen as the time of technological change, settled communities and the construction of communal monuments. Farming was established and forest cleared for cultivation. An expanding population put pressure on available resources and necessitated the utilisation of previously marginal land. During these periods the River Thames would have been a significant influence upon human activity in the vicinity. The GLHER notes a Neolithic flint axe recovered by chance from the Thames foreshore at the western end of the study area (**HEA 13**), and a flint flake (**HEA 21**) found by chance near Clapham Road, *c* 400m south-west of the proposed Kennington worksites. The GLHER also includes the approximate location near the west end of the study area of a Bronze Age spearhead found by chance in 1865 during construction of the Southwark and Vauxhall Water Works (**HEA 57**), close to the Battersea station site.

4.2.4 Much of the western end of the proposed route would have remained a marshy wetland landscape periodically inundated during flood events and strong tidal surges. Marine transgressions (rising sea levels) at the end of the early prehistoric period resulted in inundation of the low-lying areas, creating an intertidal marshland landscape crossed by numerous small creeks and fleets. Areas of open marsh, reed formation and small outcrops of woodland would have also existed. This would have made permanent occupation quite difficult except for areas of higher ground, although the marsh would still have been extensively utilised for more transient activities such as hunting, fishing and salt production.

4.2.5 The periods of marine regression (falling sea level) would have created a far drier and more accessible environment and this would have encouraged perhaps semi-permanent occupation of the area and a changing pattern of usage. The low lying marshland would have been important for a broad range of activities including grazing, fishing, fowling, salt making and pottery manufacture, and as a source of raw materials such as willows, reeds and rushes. Timber trackways or platforms may have been constructed, providing dry routes across the marshes, and a network of creeks and fleets would have provided the most direct access to the River Thames from the higher ground on which any settlements would have been located.

4.2.6 The oldest archaeological remains or features (e.g. early prehistoric), if present, would be at the base of the alluvial sequence, possibly cutting the top of the underlying gravels, with later remains progressively higher associated with successive episodes of inundation and regression. The waterlogged conditions and the ‘protective’ layer of alluvium in the vicinity of the former Battersea Creek mean that any wood or other organic remains may be well preserved.

4.2.7 In the eastern and extreme south-western parts of the proposed route, the land gradually rises up over a higher area of the sand and gravel terrace, known as an eyot. This ground would have been more suitable for settlement and could contain archaeological evidence of dry land activity, either as material on top of the natural or distributed higher up within buried soil horizons, or as features cut into the surface of the gravel and overlying deposits.

Roman period (AD 43–410)

4.2.8 Within approximately a decade of the arrival of the Romans in AD 43, the town of *Londinium* had been established on the north bank of the Thames where the City of London now stands. It quickly rose to prominence, becoming a major commercial centre and the hub of the Roman road system in Britain. A bridge, possibly the only permanent Thames crossing was constructed across the Thames, perhaps as early as the mid-1st century AD (Milne 1985, 54) close to the position of modern London Bridge: its southern approach was approximately on the line of Borough High Street.

4.2.9 Away from the bridgehead, the low-lying land south and east of the Thames is thought to have been sparsely occupied. The eastern end of the study area lay, however, on the drier gravel terrace, and was crossed by the road running south from London Bridge (later known as Stane Street) which connected *Londinium* with the Channel ports and. A branch left this road in the vicinity of Kennington Park, and ran south towards the agricultural and industrial resources of the Weald and South Downs, on or close to the line of modern Brixton Road (Margary 1967, 55, 59, 62, 64). The APA shown on Fig 2 follows the likely route of these roads, with their junction lying above the proposed southbound running tunnel to the south-west of Kennington Park.

4.2.10 It is traditionally believed that there was an early Roman river crossing in the Lambeth area, based largely on the possible remains of a Roman road excavated in the grounds of Lambeth Palace in 1935 (Survey of London 1951, 1), *c* 1.2km north of the eastern end of the proposed route.

4.2.11 Burial of the dead was forbidden within settlements: cemeteries were generally located along the major roads outside the towns, and isolated burials also took place: many Roman burials have been recorded in Southwark (AGL 2000, 149). Alongside the roads were small settlement or farmsteads, and areas of quarrying. Outside the settlements were extensive farm estates.

4.2.12 During this period, the eastern part of the proposed route would have been on dry ground suitable for settlement and other activity, whilst the remaining parts of the route lay on the low-lying floodplain. This area would have been prone to flooding and while unsuitable for habitation, might have been exploited for a number of inter-

tidal resources, e.g. fishing, salt from evaporation and clay for pottery. Throughout the Roman period the climate became warmer and drier, so it is possible that some attempt was made to drain this area for agricultural use.

4.2.13 Few remains dated to this period have been recovered within the study area. A single sherd of redeposited Roman pot was found *c* 90m south-west of the proposed Radcot Street temporary grouting shaft and worksite during an archaeological watching brief in 2004 (**HEA 11**).

4.2.14 At the western end of the study area, the HER includes the approximate site of the discovery in 1794 of a Roman lead coffin and four skeletons (**HEA 14**). This was reported in Battersea Fields, now the area west of the proposed Battersea station mostly covered by Battersea Park. The coffin, ornamented with scallop shells and cable mouldings, was later melted down and the skeletons lost. According to the HER, around 1857, a Roman bronze coin of Antonius Pius, minted *c* AD 144 was also found in the area (**HEA 15**). A possible Roman anchor, iron spearhead, javelin head or dart, the soles of several shoes, and a sword sheath were also found during the construction of Chelsea Bridge, *c* 640m to the north-west of the proposed Battersea station site.

Early medieval (Saxon) period (AD 410–1066)

4.2.15 The Roman administration of Britain collapsed in the early 5th century AD. Germanic settlers arrived from the Continent; the basis of their economy was agriculture and early Saxon settlement was exclusively rural. In the immediate post-Roman period, the established roads may still have been used as dry routes through the low-lying ground of the area, but possibly with little maintenance.

4.2.16 In the 7th to 9th centuries rural settlement developed with minsters (religious centres) and royal estate centres, and the trading port of *Lundenwic* flourished on the north bank of the Thames in the area now occupied by Aldwych, the Strand and Covent Garden (Cowie and Blackmore 2008, xv). Battersea is referred to in a charter dated AD 693 (known from a late 11th century copy) confirming a grant of land to the Abbey of Barking. A riverside settlement is likely to have been established by the late-7th century, probably close to the Thames *c* 2.1km south-west of the proposed Battersea station, where a small Middle-Saxon occupation site (*c* AD 750–800) was archaeologically excavated in 1975–8. A possible area of settlement is centred on Vauxhall *c* 800m north of the proposed route. There is no direct evidence for any Saxon settlement within the study area.

4.2.17 During this period, the eastern part of the NLE route would have been on higher/dry ground on the gravel terrace, whilst the remaining part of the route lay on the low-lying floodplain and prone to flooding. Efforts may have been made to drain marshland in the area to provide pasture, and the banks of the Thames and its associated tributaries would have been potential sites for wharves, for boat repair or fishing but there is little indication of Saxon occupation. In the early part of this period, the higher ground may have been wooded, but later was more likely to have been open land, either cultivated or used as pasture. Although much of the proposed route was in areas unsuitable for habitation, it would have provided access to valuable river resources.

4.2.18 From this time, documentary references begin to appear to manors, large landed estates which were often the centre of local administration: their boundaries frequently coincide with later parish boundaries and/or topographical features. The position of the Battersea settlement, close to the site of the later parish church, may suggest it was within a Saxon manorial estate (Cowie and Blackmore 2008, 101–5). Domesday Book (1086) records that, by the end of the period, Earl Harold held Battersea (sometimes known as the manor of Battersea and Wandsworth). It included arable land, meadow\and woodland, and seven mills (Domesday, eds Williams and Martin 1992, 76; VCH Surrey iv, 8–17).

4.2.19 The central part of the NLE (in the London Borough of Lambeth) was in the manor of South Lambeth, which during this period seems to have covered the areas of modern Vauxhall and Kennington, south-west of the Oval and possibly extending south to include modern Stockwell and part of Brixton. The parish church of St Mary at Lambeth was founded some time before 1066, near the edge of the Thames, *c* 1.2km to the north of the study area (Survey of London 1951, 104–117). It would probably have formed an early focus for settlement.

4.2.20 The eastern part of the NLE (in the London Borough of Lambeth) was in the manor of Kennington. This consisted of a large area on either side of Kennington Lane, between Black Prince Road and Vauxhall. To the south the manor was separated from Vauxhall by the northern arm of Vauxhall Creek (sometimes called the River Effra) which divided into two streams, just west of where the Oval now lies, before entering the Thames (Survey of London 1951, 57–59). The manor was owned by King Edward (the Confessor), and the name may derive from *kyning-tun*, the place of the king (Weinreb and Hibbert 1995, 433). Alternatively, it may be a reference to the land or farmstead of *Coena* (Dawson 1976, 5). At the time of the Conquest (1066) the manor of Kennington included arable land and meadow (*Domesday*, eds Williams and Martin 1992, 87; VCH *Surrey* iv, 50–64). A later medieval manorial centre grew up close to St Anselm's church in Kennington, just north of the study area (**HEA 56**), and it has been suggested (Renier 2006, 14) that a manor house existed there by the early 11th century. However, no evidence for occupation or structures prior to the mid-11th century was found during excavations close to the church in the 1960s (Dawson 1976, 9). The APA on the northern edge of the study area (Fig 2) corresponds approximately to the extent of the later manorial precinct.

4.2.21 The extreme north-eastern part of the NLE route, including the proposed Harmsworth Street temporary grouting shaft and worksite (in the London Borough of Southwark) lay in the manor of Walworth, later Newington, the western boundary of which was largely formed by the old Roman road running south from London Bridge. The manor is thought to be Saxon in origin, meaning a farm held or worked by the serfs or Britons, and a settlement and later manor house may have been in the vicinity of an early church on modern Manor Road, *c* 600m to the north-east of the Harmsworth Street site. In the early 11th century the manor (estate) of Walworth was presented by King Edmund to a court jester, Hitard, who bequeathed it to the Prior and Convent of Christ Church, Canterbury (Survey of London 1955, 81–90). The accounts of the manor in the Canterbury Cathedral archives mention income from wool, poultry, and beekeeping (Boast 2005, 4); it is likely that much of the land was used for cultivation or pasture.

4.2.22 No early medieval finds or features have been recorded during archaeological investigations in the study area.

Later medieval period (AD 1066–1485)

4.2.23 After the Conquest (1066), Earl Harold's manor of Battersea was acquired by the Abbey of Westminster. *Domesday Book* (1086) states that it was the gift of William I in exchange for Windsor, although it may be that Battersea was given for the redemption of the crown regalia pledged to the Abbey before 1066 by King Edward the Confessor. Between 1076 and 1082 William granted to the Abbot and monks of Westminster the right of hunting in the woods belonging to Battersea (VCH *Surrey* iv, 8–17).

4.2.24 In the western part of the study area, activity and buildings associated with boats or fishing are likely to have spread west along the riverfront to the north of the proposed route, and marginal areas would have been used for the cultivation of reeds or willows. Progressive drainage, reclamation and embanking would have taken place along the river, making the land increasingly suitable for cultivation and pasture. The Battersea Channel may have been reduced to a ditch or sewer by this time.

4.2.25 A manor house of possible medieval date is noted in the GLHER (**HEA 23**), on Nine Elms Lane *c* 450m north-east of the Battersea station site. No further details are given, and the GLHER entry may be derived from Ordnance Survey maps of 1874 onwards, which mark the site of a manor house. No manor of Nine Elms is recorded in Domesday, however, and other documentary sources make no reference to it. Rocque's map of 1746 (Fig 4), shows several large buildings at what was then the western end of Nine Elms Lane, but does not identify them.

4.2.26 The eastern part of Battersea parish probably remained largely uninhabited in the medieval period and Vauxhall was only a small settlement clustered around the road junction of Kennington Lane, Lambeth High Street/Albert Embankment, Wandsworth Road and South Lambeth Road.

4.2.27 The manor of South Lambeth, in the central part of the NLE route, was acquired by King Edward I in the late 13th century and appears to have been divided to form two manors: Vauxhall (to the north) and Stockwell (to the south). Settlement developed at South Lambeth (**HEA 12**), *c* 350m east of the proposed Nine Elms station site: the settlement area is designated as an APA where the proposed route crosses South Lambeth Road (Fig 2).

4.2.28 By 1260 the manor of Kennington, in the eastern part of the route, was held by William de Fortibus, Earl of Albemarle (Dawson 1976, 9–11; Survey of London 1951, 6–7). The manor changed hands several times and by 1337 had reverted to the Crown. It was granted by Edward III to Edward, Earl of Chester and Duke of Cornwall, commonly known as the Black Prince, who took up residence in the manor house which became known as the Black Prince's Palace, or Kennington Palace (Survey of London 1951, 5–6). Archaeological excavations in 1965–8 (**HEA 56**), revealed evidence of two main building phases between *c* 1340–1360, and documentary sources suggest various repairs and alterations over the next century: one of the most notable clerks of the works there was Geoffrey Chaucer, who was appointed in 1389 (Dawson 1976, 47–51). Kennington continued as a royal palace for the remainder of the period.

4.2.29 New roads were established during this time, including Kennington Lane, Black Prince Road and Lambeth Road. In eastern Battersea it is unlikely that there were any roads except paths along the river embankment and through the meadows that covered much of the area. There was a bridge over the River Effra at Vauxhall by 1279 but no other medieval bridges are known. There was, however, a ferry across the Thames at Lambeth, which ran until Westminster Bridge was constructed in the mid-18th century.

4.2.30 As in earlier periods, the higher ground to the east would have been the first choice for settlement, providing dry and fertile land with good assess to river resources.

Post-medieval period (AD 1485–present)

4.2.31 In 1501, Kennington Palace was used by Catharine of Aragon when she came to England to marry Prince Arthur, son of Henry VII. Arthur died the following year, and Catherine married his younger brother Henry VIII in 1509: it was Henry who, in 1531, ordered the demolition of the Palace. The materials were loaded onto barges at Vauxhall and used to build Whitehall Palace, *c* 2km to the north-west (Survey of London 1951, 7).

4.2.32 Rocque's 1746 map of London (Fig 4) shows the western end of the NLE and the Battersea station site in Battersea Common Field. As common land, it is unlikely that this area had been previously developed. This may be due to it being marshy throughout much of its early history. The remainder of the route crosses land that is largely rural, with scattered hamlets. Settlement is shown close to the Thames at Nine Elms and Vauxhall, and these areas are surrounded by cultivated fields and market gardens. Buildings and a bridge are also shown in the vicinity of South Lambeth (in the area covered by the APA, crossed by the proposed route), and on

the western side of Kennington Common, much of which is now Kennington Park. At the extreme north-eastern end of the proposed route, the Kennington Green permanent shaft and headhouse site lies within market gardens; the other sites in this area are largely open pasture.

4.2.33 The Ordnance Survey 1":mile map of 1822 (Fig 5) shows a small settlement called Battersea New Town established at the end of Nine Elms Lane, on the eastern side of the former Battersea Common Field between the proposed Battersea and Nine Elms stations. The settlement housed the increasing numbers of workers in the industries in the vicinity, such as the London Gas Works, established by the Gas Light and Coke Company in 1833, on Nine Elms Lane *c* 460m north-west of the proposed Nine Elms Station. The subsequent expansion of the gas works and other 'noxious' industries defined the area for much of the 19th and 20th centuries. In the 1820s, however, there was still much open ground, probably market gardens supplying the rapidly rising population of London. This growth is reflected in the eastern part of the study area which had been rapidly developed with residential housing, losing much of its former rural character. The later medieval roads remained as the main highways in the area, largely lined with houses.

4.2.34 By 1848 the London and South Western Railway had built a line running from London to Southampton, crossing the study area and passing *c* 100m north-west of the proposed Nine Elms station site (Cherry and Pevsner 2002, 673). The Church of St. George, built in 1828, and its graveyard (**HEA 55**) was located *c* 200m east of the proposed Battersea station site. The Southwark and Vauxhall Water Works (**HEA 57**) and its associated reservoirs were constructed from 1839–40 to 1856 beside the Thames to the north of the proposed Battersea station site.

4.2.35 In the mid-19th century, Battersea Park was laid out to the west of the study area; the low-lying ground of the old Battersea Fields was artificially raised to create the Park, and it opened in 1853. Stanford's map of London, dating to 1862 (Fig 6), shows New Road running north-east from a circus at the south-eastern corner of the new park, across the proposed Battersea station site to join Nine Elms Lane *c* 400m to the north-east. The road is not shown on later maps and it is possible that it was never completed, or was soon obliterated by the subsequent expansion of the Southwark and Vauxhall Water Works.

4.2.36 Away from the riverfront, large areas in the western part of the study area were still market gardens as shown on Stanford's map. Further east, much of the length of Wandsworth Road had been developed, with large houses and villas, with large gardens to the rear, but with meadow land remaining to the south-west. The proposed Nine Elms station site is shown as part of the Vauxhall Brewery to the north, with houses or shops, and rear gardens, in the southern part of the site, with a cricket ground adjacent to the north.

4.2.37 Possible quarry pits identified during archaeological investigations immediately to the north of the proposed Nine Elms station site at 66–68 Wandsworth Road (**HEA 41**) contained a deep sequence of mid to late 19th-century deposits, and may have been associated with the urban development of the area, and particularly the construction of the nearby railway line.

4.2.38 The eastern end of the proposed route crosses an area of relatively more dense 19th century terraced housing, although large areas are private gardens. The Surrey County Cricket Ground was established at The Oval in 1845, and Kennington Park (**HEA 32**) was laid out on part of Kennington Common in 1852–54.

4.2.39 The London County Council's Bomb Damage maps show that, like much of central and industrial London, the study area was heavily bombed during the Second World War. The maps show that the area south-west of the Oval was badly affected: the major rail routes and the industrialised areas of Nine Elms and Battersea would have been particular targets, and many of the houses and other buildings are marked as seriously damaged or totally destroyed. Less serious blast damage was

widespread along the area of the proposed route (LCC 1939–45, Maps 88−89).

4.2.40 During the second half of the 20th century, the western part of the study area has been characterised by light industrial and warehouse development. To the east, 19th century terraced houses have been replaced in many areas by blocks of flats.

5 Site-Specific Assessment Worksheets

5.1 Introduction

5.1.1 This section discusses each site in detail. Listed buildings and other potential (non-designated) above-ground heritage assets in the vicinity of each site are identified. In accordance with the NPPF a statement is provided – based on professional and expert judgement – on the likely significance (which is a reflection of the value or importance) of above ground heritage assets, derived from their perceived historical, evidential, aesthetic and communal value.

5.1.2 The archaeological and historic background of each site is presented to inform an assessment of likely past impacts which may have compromised archaeological survival, such as quarrying, or late 19th and 20th century development. In accordance with the NPPF, this is followed by a statement on the predicted potential for and likely significance of buried heritage assets within the site, derived from current understanding of the baseline conditions, past impacts, and professional judgement.

5.2 Battersea station

NORTHERN LINE EXTENSION PROJECT Historic Environment Site-Specific Assessment Worksheet	
Site Name:	**Battersea station**
NGR	529060 177275
Borough	Greater London Borough of Wandsworth
Address	Battersea Park Road
Outline of proposed works	• Establishment of worksite • Construction of conveyor, and works to existing Thames-side jetty • Construction of a new underground train station, crossover box and overrun tunnels
Historic Environment Baseline	
Designated heritage assets	• Battersea Power Station, Grade II* listed (**HEA 58**), including waterside cranes, jetty and intake and outlet chambers as subsidiary structures • Battersea Water Pumping Station, Grade II listed (**HEA 57**)
Non-designated heritage assets	• Access conveyor and jetty are within an APA covering the Thames riverside. • Alluvial deposits with potential for palaeoenvironmental remains and preserved organic remains of all periods. • Market garden, devoted to the production of fruit and/or vegetables shown on 19th-century maps (**HEA 49**). • New Road, shown on Stanford's map of 1862 extending north-east form Battersea Park but possibly removed by the expansion of the Southwark and Vauxhall Water Works. • Late 19th-century reservoir of the Southwark and Vauxhall Water Works. • Early 20th-century goods depot and associated track and buildings of the South Western Railways (later South Lambeth Goods Depot) (**HEA 50**). • Battersea Gas Holders (**HEA 59**). • The Whittington Lodge by Sir Clough-Williams Ellis (1906), the sole-surviving pre-war building on the Battersea Dogs and Cats Home site (**HEA 104**). • Railway viaducts to the east and west of Battersea Dogs and Cats Home • The river embankment wall north of Battersea Power Station, mid-19th century or earlier • Bargebed to the north of the river wall
Geology and topography	Ground level on the station site slopes from south-west to north-east, from *c* 4.3m Ordnance Datum (OD) at Battersea Park Road, immediately to south-west of the site, to *c* 3.9m OD at Battersea Park Road, immediately to south-east of the site. The station site lies on the Kempton Park Gravel terrace, which would be found at *c* 2.0m OD in the site (*c* 2.0m below ground level) (MOLA 2009). The conveyor and jetty lie on river alluvium.
Archaeological and historical	During the prehistoric periods the station site would be located on an island of higher ground that would have been suitable for settlement and close to the

summary	predictable resources of the River Thames. This part of the site could contain evidence of dry land activity, either as archaeological material scattered on/within buried soil horizons, or as features cut into the surface of the gravel surface and its overlying horizons. The conveyor route extends to the banks of the Thames, and could contain evidence of river-edge activity, such as fishing, boat construction or repair, timber trackways and revetments. During the Roman and early medieval periods the intertidal resources might have been exploited for fishing, boat repair, salt from evaporation and clay for pottery. The scarcity of Roman and early medieval remains located in the vicinity suggests that the area was not a focus of settlement or activity during these periods. It is possible that reclamation of the low-lying areas close to the site started in the later medieval period with the high ground area of the site providing dry and fertile land with good access to the river and its tributary. Early post-medieval maps (see below) show no settlement here and indicate that the site probably lay within the common fields of Battersea, *c* 2km to north-east of the main Battersea settlement. As such, the site is unlikely to have been developed. During the early post-medieval period the site remained undeveloped. Rocque's map of 1746 shows the site in open fields, close to a group of windmills at the edge of common fields ('Battersea Fields'), to the north of the current Battersea Park Road. Stanford's map of 1862 shows the station site within Market Gardens, possibly crossed by New Road. The conveyor route crosses the edge of the Southwark and Vauxhall Water Works. The Ordnance Survey 2nd edition 25":mile map of 1897 shows the enlargement of the mid 19th-century Southwark and Vauxhall Water Works with the construction of a reservoir across the entire station site. In the early 20th century the southernmost reservoir was partially backfilled and the station site was occupied by the sidings and goods depot of the Great Western Railway, as shown in the Ordnance Survey 3rd edition 25":mile map of 1916, with the Water Works remaining *in situ* to the north. The goods depot was consecutively enlarged up to its maximum extent in 1951 (Ordnance Survey 1:2500 scale map of 1951). Battersea Power Station was shut down in 1983 and the railway depot ceased to operate.
Past impacts	Construction of the Southwark and Vauxhall Water Works reservoir in the area of the site, down to *c* 0.3m OD (Berry & Dean 1937, 38), would have truncated the underlying natural geology and removed completely archaeological remains, other than the bases of any very deep cut features (such as wells, pits, ditches, etc) cut into the underlying gravels.
Archaeological potential and statement of significance	Survival potential for buried remains at the worksite and southern part of the conveyor route might comprise the bases of features cut into the underlying gravel and, potentially, remains of the 19th-century reservoir and 20th-century railway depot within the made ground. The conveyor and jetty lie within an Archaeological Priority Area covering the Thames riverside. Here, remains may comprise alluvial deposits containing palaeoenvironmental evidence, and remains of riverside structures of the prehistoric to post-medieval periods. • High potential for remains of the early 20th-century goods depot and associated railways and buildings. **Low** significance. • High potential for palaeoenvironmental remains, of **medium** significance for the understanding of past landscapes • Moderate potential for remains of the late 19th-century reservoir. **Low** significance. • Moderate potential for remains of riverside structures and organic remains, potentially of **medium to high** significance, depending on nature, date, extent and state of preservation, • Low potential in the worksite for remains of prehistoric to medieval

	periods. **Low to medium** significance depending on date, nature, extent and preservation. • Low potential for evidence of the construction across the site of New Road in the mid-19th century. **Low** significance. • Very low potential for remains/deposits associated with the Market garden. **Low** significance.
Built heritage potential and statement of significance	The site is within the setting of two listed structures, Battersea Power Station (**very high** significance) and Battersea Water Pumping Station (**high** significance). The waterside cranes north of Battersea Power Station (**HEA 58**) are included in that building's listing and are therefore of **very high** significance. The jetty and intake and outlet chambers are within the curtilage of Battersea Power Station and therefore assumed to be of **very high** significance. Whittington Lodge (**HEA 104**) of **medium** significance. There are also a number of other unlisted structures within the vicinity of the site, such as walls and gates of the former pumping station that may form part of the setting of the listed structures. Railway viaducts east and west of Battersea Dogs and Cats Home that are of **low** significance. The river embankment wall north of Battersea Power Station is of **low** significance, but collectively with the Power Station and bargebed might be of **medium** significance.
Current Design	
Reference:	Based on information in ES Chapter 4: *Description of the NLE*, and the *Deposited Plans and Sections* drawings submitted as part of the TWAO Application.
Description	• Site preparation groundworks, assumed across entire site footprint • Demolition of any existing structures on station site • Temporary dismantling and removal of listed cranes • Works to jetty and river wall, and dredging • Preparation of station worksite, foundations for tower cranes • Construction of access conveyor adjacent to listed Battersea Water Pumping Station (**HEA 57**) and works to existing Thames-side jetty, including temporary removal of listed cranes (under listed building consent for Battersea Power Station), minor dredging and possible piling • Sheet pile retaining wall at the excavation side close to Battersea Park Road; other sides of the excavation area will be battered • Diaphragm wall (retaining wall): excavation of 1.2m wide trench around perimeter of ticket hall, station and crossover box footprints • Northern access to station, lowest floor level –6.0m OD: excavation across the entire footprint of the access hall down to *c* –6.7m OD (*c* 10.0m below ground level) • Station box, lowest floor level –16.5m OD; Crossover box, base at *c* –15.2m OD: excavation across the entire footprint down to *c* –17.3m OD (*c* 22.0m below ground level) • Running tunnels continuing west of the station box beneath Whittington Lodge (**HEA 104**), which – along with any other buildings at Battersea Dogs and Cats Home at risk from settlement – would be underpinned prior to their construction
Impact	• Preparatory ground reduction prior to cut-and-cover excavation will remove any archaeological remains within its footprint down to the proposed level. This will include any remains of the 19th-century reservoir and 20th-century

	railway structures, as well as deep cut features which might have survived the 19th-century waterworks development. The significance of any possible remains would be reduced to **negligible**. • Construction of the access conveyor will remove any archaeological remains within the footprint of ground disturbance down to the proposed level: construction of supporting piles will remove and remains within the footprint of each pile. The significance of any possible archaeological remains would be locally reduced to **negligible**. Palaeoenvironmental remains (a resource assumed to extend beyond the site) would be removed locally, with significance reduced to **low or negligible**, depending on extent of deposits. • Ground-intrusive works to the existing Thames-side jetty will have a potential impact, truncating or removing entirely possible prehistoric or later structures: their significance would be reduced to **negligible**. • Dredging may have an impact if undertaken to a deeper extent than previously will have an impact on any remains associated with the foreshore. The significance of any possible archaeological remains would be locally reduced to **negligible**. • Listed building consent (LBC) will be required for any works associated with Battersea Power Station, its subsidiary structures and structures within its curtilage. Structural works to the existing Thames-side jetty have the potential to reduce its significance. It is likely that this would have **no effect** overall however on the significance of Battersea Power Station. • The temporary removal of the listed cranes would, if undertaken in accordance with LBC conditions, be likely to have **no permanent effect** on their significance or that of Battersea Power Station, but would be a temporary **adverse** impact on appreciation of the asset during the construction phase. • Construction of station box retaining wall will remove any archaeological remains within its footprint. The significance of any possible remains would be reduced to **negligible**. • Excavation for the northern access hall will remove the base of any very deep cut features that might have survived the ground level reduction. The significance of any possible remains would be reduced to **negligible**. • Excavation of the cut-and-cover station and crossover boxes will remove the base of any very deep cut features that might have survived the ground level reduction. The significance of any possible remains would be reduced to **negligible**. • The possible impact of settlement on Whittington Lodge and on the Battersea Dogs and Cats Home and the railway viaducts to its east and west would be prevented by underpinning, resulting in **no effect** on significance. This may however have an archaeological impact, depth and extent to be determined following further monitoring and geotechnical investigations.
Mitigation Strategy	
Ground level reduction and conveyor construction	• Archaeological monitoring of geotechnical investigations to confirm predicted levels of natural geology, thickness of made ground and presence of potential archaeological deposits. • Archaeological watching brief during ground reduction works in order to record any potentially surviving archaeological remains, to achieve preservation by record.
Structural works to jetty	• The cranes, jetty and intake and outlet chambers should be subject to an further inspection to determine appropriate mitigation, likely to comprise a record at English Heritage Level 1 or-2 prior to the commencement of works.

Dredging	• Where archaeological assets within the foreshore may be affected, mitigation would be prior archaeological investigation, with mitigation (preservation by record) in the form of watching brief and/or excavation depending on position above or below the water level.
Retaining wall and cut-and-cover excavation	• An archaeological watching brief during excavation for the access hall and station and crossover boxes, in order to record any potentially surviving archaeological remains, to achieve preservation by record.
Tunnel excavation	• The possible impact of settlement on Whittington Lodge and on the Battersea Dogs and Cats Home and the railway viaducts to its east and west would be mitigated by underpinning, resulting in **no effect** on significance. This may however have an archaeological impact, depth and extent to be determined following further monitoring and geotechnical investigations. • Archaeological mitigation for the effects of underpinning or other settlement mitigation would depend on the depth and extent of ground disturbance, to be determined once further information is available.
Building works	• No mitigation against physical impacts from above-ground works on built heritage is required.

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Ordnance Survey 1:10000 scale map of 1987

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Approved by MOLA	George Dennis		05-03-2013
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Approved by MOLA	George Dennis		20-03-2013

5.3 Nine Elms station

NORTHERN LINE EXTENSION PROJECT Historic Environment Site-Specific Worksheet	
Site Name:	**Nine Elms station**
NGR	529985 177345
Borough	Greater London Borough of Wandsworth
Address	Wandsworth Road / Pascal Street
Outline of proposed works	• Establishment of worksite • Construction of a new underground train station
Historic Environment Baseline	
Designated heritage assets	• Immediately to the east of an APA as designated by the local authority, which reflects the archaeological potential of the Thames floodplain and the valley of an ancient tributary of the Thames.
Non-designated heritage assets	• Wandsworth Road. Late medieval well. Also called fauxwell, foxhall well. Still in use in 1856 (**HEA 26**). • Wandsworth Road. Site of the Wood Bridge, by 1592 (**HEA 28**). • Wandsworth Road SW8. Observations for SLAEC in 1981 noted only a shallow trench of apparently 17th or 18th-century date (**HEA 39**). • 66–8 Wandsworth Road. MoLAS evaluation in 1993 (**HEA 41**). A series of dumps of clay of a mid–late 19th-century date were recorded. The expected natural gravel was not found, despite augering, and the site was interpreted as that of a gravel extraction pit, presumed to be associated with the construction of the nearby railway. • Mid 19th-century stores. • 20th-century industrial buildings. • A railway viaduct to the west of the site. • Adrian House and Basil House, east of the site. • Victoria Mansions, east of the site.
Geology and topography	Ground level slopes from *c* 3.4m Ordnance Datum (OD) at the junction of Wandsworth Road and Pascal Street, immediately to the south-east of the site, to *c* 1.9m OD at the western end of Pascal Street, immediately to the west of the site. The western part of the site lies on floodplain alluvium at the edge of the Battersea Channel. The central and eastern parts of the site lie on the Kempton Park Gravel Formation. A geotechnical borehole drilled in 2010 in Pascal Street, immediately to south of the site (Halcrow Group Ltd, July 2010, BH2), recorded 1.2m of made ground over alluvium at *c* 0.5m OD, overlying the terrace gravels at *c* –1.9m OD (*c* 3.6m below ground level).
Archaeological and historical summary	The western part of the site would have remained a marshy wetland landscape through much of prehistory periodically inundated during flood events and strong tidal surges. The central and eastern parts of the site are located on higher ground that would have been suitable for settlement and could contain evidence of dry land activity, either as archaeological material scattered on/within buried soil horizons, or as features cut into the surface of the gravel surface and its overlying horizons. Timber trackways may have been constructed out from the higher ground into the marsh. During the Roman and early medieval periods, the central and eastern parts of

	the site would have been dry ground suitable for settlement and other activity, whilst the western part of the site lay on the low-lying floodplain. This area would have been prone to flooding and might have been exploited for a number of inter-tidal resources, e.g. fishing, salt from evaporation and clay for pottery. The scarcity of Roman and early medieval remains recorded within the area suggests that the area was not a focus for settlement or activity during these periods. Reclamation of the low-lying areas of the western part of the site began in the later medieval period with the central and eastern parts of the site being the first choice for settlement, providing dry and fertile land with good access to the river Thames and its tributary. However, early post-medieval maps (see below) show no settlement here and indicate that the site probably lay within the fields by the later medieval road connecting Lambeth to Wandsworth. During the early post-medieval period the site remained undeveloped and under agricultural use. Rocque's map of 1746 shows the site in open fields to the west of the current Wandsworth Road, noted as Kingston Road on this map. The eastern edge of the site may have included buildings by the early 19th century as shown n the Ordnance Survey 1":mile map of 1822. Stanford's map of 1862 shows the development of a large building or terrace of houses fronting onto 'Hamilton Street' (the current Pascal Street) with gardens to the rear. The north-eastern part of the site is occupied by part of the Vauxhall Brewery building fronting onto Wandsworth Road. The Ordnance Survey 1st edition 25":mile map of 1871 shows the southern part of the site occupied by rows of houses with backyards, fronting onto Hamilton Street (now Pascal Street) and Wandsworth Road. The western and northern parts of the site are occupied by stores buildings and railway sidings associated with the lines to the west, and the timber sheds to the north. The Ordnance Survey 2nd edition 25":mile map of 1894 and the 3rd edition 25":mile map of 1913 show little change other than the enlargement of the stores building in the western part of the site, which now extends to Pascal Street. The Ordnance Survey revised edition 25":mile map of 1919 shows a large industrial building fronting onto Wandsworth Road, previously occupied by houses fronting onto Pascal Street. The London County Council's Bomb Damage Map records a V1 flying bomb exploding immediately to the south-east of the site, damaging beyond repair the houses fronting onto Pascal Street and seriously damaging the large industrial building (LCC 1939-45, map 88). The Ordnance Survey 1:2,500 scale map of 1952 shows the site occupied by the former stores and a large industrial building noted as 'Wandsworth Masonry Works'. The Ordnance Survey 1:10,000 scale map of 1987−78 shows the construction of the existing buildings during the late 1970s and early 1980s. The masonry works were demolished at the end of the 20th-century and the existing petrol station built in their place.
Past impacts	The site has been built up since the mid 19th century. The majority of these buildings probably had simple strip footings up to a maximum of 1.5m deep, the construction of which will have truncated any earlier remains or removed shallow remains entirely within the foundation footprint. The bases of deep cut features, such as pits, ditches and wells may survive beneath this truncation. The extent of any cellars of these early buildings is unknown.
Archaeological potential and statement of significance	Survival potential for buried remains of the prehistoric to medieval periods comprising the bases of features cut into the underlying gravel. Remains of 19th-century houses and 20th-century industrial buildings might survive within any made ground or cutting into the underlying geology (i.e. alluvium). • Moderate potential for geoarchaeological and palaeoenvironmental

	remains. **Medium** significance for the understanding of past landscapes. • Moderate potential for remains of mid to late 19th-century houses and storage sheds. **Low** significance. • Moderate potential for remains of the 20th-century works. **Low** significance. • Low potential for remains of Roman to medieval periods. **Uncertain** significance depending on date, nature, extent and preservation. • Uncertain potential for possible, previously unrecorded, prehistoric remains, of **uncertain (potentially high)** significance.
Built heritage potential and statement of significance	The proposed works do not impact upon any listed structures. However, they require the partial demolition of non-designated structures currently on site that should be regarded as of **low to medium** significance. A railway viaduct to the west of the site is of **low** significance. Adrian House and Basil House, east of the site, are of **low** significance. Victoria Mansions, east of the site, is of **low** significance.
Current Design	
Reference:	Based on information in ES Chapter 4: *Description of the NLE*, and the *Deposited Plans and Sections* drawings submitted as part of the TWAO Application.
Description	• Site preparation: demolition of existing buildings comprising Banham's Building, office building belonging to New Covent Garden Market, incinerator plant and Sainsbury's petrol station, remediation, temporary two-level car parking • Preparatory groundworks, assumed across entire site footprint • Preparation of worksite, foundations for tower cranes • Diaphragm wall (retaining wall): excavation of 1.2m wide trench around perimeter of station box footprint • Station box, lowest floor level –21.9m OD: excavation across the entire footprint down to *c* –23.6m OD (*c* 26.0m below ground level) • Unblocking of one arch of the railway viaduct
Impact	• Site preparation, the removal of obstructions, remediation and the erection of temporary structures where ground intrusion extends beyond modern made ground will truncate or remove any archaeological remains within the extent of the work. The significance of any possible remains might be reduced to **negligible**. • Construction of retaining wall will remove any archaeological remains within its footprint. The significance of any possible remains would be reduced to **negligible**. • Excavation of the cut-and-cover station box will remove any archaeological remains within its footprint. The significance of any possible remains would be reduced to **negligible**. • A number of unlisted buildings of heritage significance will be demolished as part of the development. • The possible impact of settlement on the railway viaducts west of the site, on Adrian House and Basil House, and on Victoria Mansions would be prevented by underpinning, resulting in **no effect** on significance. This and any other underpinning may however have an archaeological impact, depth and extent to be determined following further monitoring and geotechnical investigations.
Mitigation Strategy	

Retaining wall and cut-and-cover excavation	• Archaeological monitoring of geotechnical investigations to confirm predicted levels of natural geology and potential archaeological deposits • Archaeological trial trenches to clarify the presence, nature, date and significance of any archaeological remains that might be present. • Targeted archaeological excavation and/or an archaeological watching brief during site preparation and as the station box is excavated downwards in order to record any archaeological remains (preservation by record).
Building works	• The buildings to be demolished should be subject to an internal inspection to determine appropriate mitigation, like to comprise a record at English Heritage Level 1–2 prior to the commencement of works.

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Ordnance Survey 3rd edition 25":mile map of 1913

Ordnance Survey revised edition 25":mile map of 1919

Ordnance Survey 1:2500 scale map of 1952

Ordnance Survey 1:2500 scale map of 1970

Approvals	Name	Signed	Date
Compiled by MOLA	Guillermo Molina-Burguera		02-08-2010
Checked by MOLA	Hannah Pethen		16-08-2010
Approved by MOLA	George Dennis		31-08-2010
Revised by MOLA	Christina Holloway/James Dixon		01-05-2012
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Revised by MOLA	Christina Holloway/James Dixon		11-03-2013
Approved by MOLA	George Dennis		11-03-2013

5.4 Kennington Green permanent shaft and headhouse

NORTHERN LINE EXTENSION PROJECT Historic Environment Site-Specific Worksheet	
Site Name:	**Kennington Green permanent shaft and headhouse**
NGR	531210 178015
Borough	Greater London Borough of Lambeth
Address	Kennington Green
Outline of proposed works	• Establishment of work compound for deliveries, storage and general use. • Construction of ventilation shaft, headhouse at the entrance to the Beefeater Distillery in Montford Place ('gatehouse' wall to be demolished and rebuilt) and connecting sub-surface tunnel ventilation duct crossing Kennington Green and Montford Place, with a lower floor level of –1.5m OD. Construction of water tank for the Distillery, on Montford Place.
Historic Environment Baseline	
Designated heritage assets	• Kennington Green (**HEA 60**) • 3 and 7 – 25 Montford Place, Grade II listed (**HEA 61**) • 362, 364 and 366 Kennington Road, Grade II listed (**HEA 62**) • 356 Kennington Road, Grade II listed (**HEA 63**) • 354 Kennington Road, Grade II listed (**HEA 64**) • 350 and 352 Kennington Road, Grade II* listed (**HEA 65**) • 348 Kennington Road, Grade II listed (**HEA 66**) • 346 Kennington Road, Grade II listed (**HEA 67**) • The former Vauxhall Manor School Annexe, now The Lycee, Stannary Street, Grade II listed (**HEA 68**) • Old Town Hall, (former Church of England Children's Society), 367 Kennington Road (now private offices) Grade II listed (**HEA 69**) • 328 Kennington Road, Grade II listed **(HEA 70**) • 324A and 326 Kennington Road, Grade II listed (**HEA 71**) • 320 and 322 Kennington Road, Grade II listed (**HEA 72**) • 318 Kennington Road, Grade II listed **(HEA 73**) • Locally listed buildings 1 and 5 Montford Place (**HEA 107**) and 379 Kennington Road • Locally listed original Edwardian distillery building on Montford Place and four gas holders • Kennington Conservation Area (local designation)
Non-designated heritage assets	• Projected line of Roman Stane Street. • Projected line of medieval road connecting Kennington to Stockwell. • Industrial buildings at and behind 373 Kennington Road

Geology and topography	Ground level on the site lies at *c* 3.3m OD. The site lies on the Kempton Park Gravel Formation. A geotechnical borehole drilled in 2010 in the site (Halcrow Group Ltd July 2010, BH7), recorded the terrace gravels at *c* 1.2m OD (*c* 2.1m below ground level) overlaid by made ground.
Archaeological and historical summary	During the prehistoric period the site would have been within woodland or open fields some distance from predictable resources of the Thames. The nature and extent of any Roman occupation in the area is not well-understood. Located close to known roads, it is possible that the site may have been occupied during the period. Otherwise, it is likely to have been within open land, or possibly woodland. In the early medieval period, the site may have been in wooded and later arable or pasture land some distance from known settlements. During the later medieval period the site would have remained in open land belonging to the manor estate of Kennington. During the early post-medieval period the site remained undeveloped and under agricultural use until the late-18th century when the area started to be built up. Rocque's map of 1746 shows the site in an area of market gardens and orchards close to a path between Kennington Cross and Kennington Common. In 1751, Kennington Road was cut through from Westminster Bridge Road to Kennington Common, following the opening of Westminster Bridge in 1750. The old path was straightened, although a right-angled detour round a pond (known as Mawbey's pond after the landowner) remained. The pond was infilled in 1813 and the land enclosed by railings creating what later became known as Kennington Green. Horwood's map of 1799 shows the new street layout, with a pair of semi-detached houses facing the Green on the north side of Montford Place; the Distillery water tank site was still open ground at this time. Greenwood's map of 1822−24 shows no change. Stanford's map of 1862 shows the west end of Montford Place extended north (then known as Pilgrim Street, with a gas works to the west and terraced houses to the east, on the Distillery water tank site. The Ordnance Survey 1st edition 25":mile map of 1871 shows no change other than the tramway running along the road. The Ordnance Survey 2nd edition 25":mile map of 1894 shows no change. The 3rd edition 25":mile map of 1913 shows a large industrial or commercial building having replaced the terraced houses on the Distillery water tank site. The Ordnance Survey revised edition 25":mile map of 1919 shows no change within the Green although houses to the west have been demolished and an industrial building built. The London County Council's Bomb Damage Map records the industrial buildings to the west of the green were 'Damaged beyond repair' by two V1 flying bombs (LCC 1939-45, map 89). The Ordnance Survey 1:2,500 scale map of 1952 shows the construction of a new industrial building to the west, and no change within the green. The Ordnance Survey 1:2,500 scale map of 1970 shows no change. The arcaded 'gatehouse' wall of the Beefeater distillery west of Kennington Green is of recent construction.
Past impacts	Kennington Green was probably used for cultivation and included a pond until the mid-18th century when it was turned into a small park area within housing developments and the new street layout. No impacts other than garden works have been identified within this site. The Distillery water tank site was built up by the mid-19th century; building foundations will have removed locally any earlier remains in the site.

Archaeological potential and statement of significance	Uncertain, possibly low, potential for remains of the prehistoric to medieval periods. **Low to medium** significance depending on date, nature, extent and preservation. Moderate to low potential for remains of late 18th-century and 19th-century houses, of **low** significance, and high potential for remains of 20th-century manufacturing works, of **low** significance.
Built heritage potential and statement of significance	The site is within the setting of a number of listed structures of **high to very high** significance and within a Conservation Area of **very high** significance. The industrial buildings at 373 Kennington Road are of **low** significance.
Current Design	
Reference:	Based on information in ES Chapter 4: *Description of the NLE*, and the *Deposited Plans and Sections* drawings submitted as part of the TWAO Application.
Description	• Establishment of a work compound *c* 75m x *c* 75m • Site preparation and removal of obstructions • Piled retaining wall for shaft and sub-surface tunnel • Excavation of a 13.5m diameter shaft down to *c* −22.3m OD (*c* 25.0m below ground level) • Excavation for sub-surface tunnel ventilation duct crossing Kennington Green and Montford Place, down to *c* –2.5m OD (*c* 6.0m below ground level) • Piling for headhouse construction • Construction of Headhouse at the entrance to the Beefeater Distillery in Montford Place (existing 'gatehouse' structure to be demolished) roofline higher than existing and excavation of basement down to c –2.5m OD (*c* 6.0m below ground level) • Construction of water tank on piled foundations and a concrete slab 1.3m wide and 0.5m deep within an enclosure *c* 18m x *c* 33m at the western side of the Beefeater Distillery in Montford Place
Impact	• Preparatory groundworks which extend beyond/beneath any modern made ground would truncate or remove entirely any archaeological remains in the area of impact. The significance of any remains affected would be reduced to **negligible**. • Existing 'gatehouse' structure at the entrance to the Beefeater Distillery in Montford Place to be demolished. • Piled foundations for the water tank will remove any archaeological remains within the footprint of each pile. A slab foundation will remove any archaeological remains to its maximum depth, and truncate any remains beneath. • Construction of retaining wall will remove any archaeological remains within its footprint. The significance of any possible remains would be reduced to **negligible**. • Excavation for the shaft, ventilation tunnel and headhouse basement will remove any potential archaeological remains within their footprint. The significance of any remains affected would be reduced to **negligible**. • The possible impact of settlement on 362 – 366 Kennington Road and on the industrial buildings behind 373 Kennington Road would be prevented by underpinning, resulting in **no effect** on significance, but may have an archaeological impact, depth and extent to be determined following further monitoring and geotechnical investigations..
Mitigation Strategy	

Site preparation, water tank base construction, retaining wall, shaft, tunnel and headhouse basement excavation	• Archaeological trenched evaluation to clarify archaeological potential within the footprint of the shaft, headhouse, connecting tunnel and tank. This could be combined with any geotechnical investigations • Depending on the results of the evaluation, targeted archaeological excavation and/or an archaeological watching brief during ground reduction, in order to record any potential archaeological remains (preservation by record). It is possible that the evaluation will establish that no further work is necessary.
Building works	• The underpinning of 362 – 366 Kennington Road would require listed building consent.

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Ordnance Survey revised edition 25":mile map of 1919

Ordnance Survey 1:2500 scale map of 1952

Ordnance Survey 1:2500 scale map of 1970

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5.5 Radcot Street temporary shaft and worksite

NORTHERN LINE EXTENSION PROJECT Historic Environment Site-Specific Worksheet	
Site Name:	**Radcot Street temporary northbound grouting shaft and worksite**
NGR	531390 178110
Borough	Greater London Borough of Lambeth
Address	Radcot Street
Outline of proposed works	• Establishment of a work compound for deliveries, storage and general use. • Construction of a shaft 5.0m diameter and 27.0m deep
Historic Environment Baseline	
Designated heritage assets	• 164 – 170 and 170A Kennington Park Road, Grade II listed (**HEA 74**) • 140 – 162 Kennington Park Road, Grade II listed (**HEA 75**) • 125 – 165 Kennington Park Road, Grade II listed (**HEA 76**) • 136A Kennington Park Road, Grade II listed (**HEA 77**) • The White Bear Pub, Grade II listed (**HEA 78**) • 114 – 124 Kennington Park Road, Grade II listed (**HEA 79**) • 21 – 25 Cleaver Square, Grade II listed (**HEA 80**) • 26 – 33 Cleaver Square, Grade II listed (**HEA 81**) • 126 – 132, Kennington Park Road, Grade II listed (**HEA 83**) • Kennington Conservation Area (local designation)
Non-designated heritage assets	• Projected line of Roman Stane Street. • Projected line of medieval road connecting Kennington to Stockwell. • Wall at rear of 164 Kennington Park Road (**HEA 82**) • 5 – 9 and 8 – 14 Ravensdon Street • 1 – 6 Radcot Street
Geology and topography	Ground level on the site lies at *c* 3.8m OD. The site lies on the Kempton Park Gravel Formation. A geotechnical borehole drilled in 2010 in the site (Halcrow Group Ltd July 2010, BH8), recorded the terrace gravels at *c* 2.2m OD (*c* 1.6m below ground level) overlaid by made ground.
Archaeological and historical summary	During the prehistoric period the site would have lain within woodland or open fields some distance from the predictable resources of the Thames. The nature and extent of any Roman occupation in the area is not well-understood. Located close to known roads, it is possible that the site may have been occupied during the period. Otherwise, it is likely to have been within open land or, possibly, woodland. In the early medieval period, the site may have been wooded and later arable or pasture land some distance from known settlements. During the later medieval period the site would have remained in open land belonging to the manor estate of Kennington. Kennington manor house stood *c* 300m to the north-west of the site. During the early post-medieval period the site remained undeveloped and under agricultural use until late-18th century when the area started to be built up. Rocque's map of 1746 shows the site in open fields to the west of the current Kennington Park Road. Horwood's map of 1799 shows the site within open ground crossed east-west by a boundary fence or wall, amongst newly developed terraces fronting onto 'Princess Square' (now Cleaver Square), and 'Queens Row' (now Ravensdon Street). Greenwood's map of 1822−24 and Stanford's map of 1862 show no change to this layout. The Ordnance Survey 1st edition 25":mile map of 1871 shows the current layout of streets and buildings. The Ordnance Survey 2nd edition 25":mile map of 1894 and the 3rd edition of 1914 show no change. The London County Council's Bomb Damage Map records 'Blast damage, minor in nature' in the vicinity of the site (LCC 1939-45, map 89). The Ordnance Survey 1:2,500 scale maps of 1952 and 1970 show no change.
Past Impacts	The site has been within open ground until the mid-19th century when it was incorporated into newly developed streets between terraced housing. No past impacts other than street surface and service works have been identified within the site.
Archaeological potential and statement of significance	Low potential for remains of prehistoric to post-medieval periods. **Low to medium** significance depending on date, nature, extent and preservation.
Built heritage potential and statement of significance	The site is within the setting of a number of listed structures of **high** significance and within a Conservation Area of **very high** significance. Numbers 5 – 9 and 6 – 14 Ravensdon Street and 1 – 6 Radcot Street are of **medium** significance
Current Design	
Reference:	Based on information in ES Chapter 4: *Description of the NLE*, and the *Deposited Plans and Sections* drawings submitted as part of the TWAO Application.
Description	• Establishment of a work compound *c* 48m x *c* 9m • Site preparation and removal of obstructions • Retaining wall for shaft • Excavation of a 5.0m diameter shaft down to *c* −23.2m OD (*c* 27.0m below ground level)
Impact	• Preparatory groundworks which extend beyond/beneath any modern made ground would truncate or remove entirely any archaeological remains in the area of impact, reducing significance to **low** or **negligible**. • Excavation of the shaft will remove any archaeological remains within its footprint. The significance of any possible remains would be reduced to **negligible**. • The possible impact of settlement 5 – 9 and 6 – 14 Ravensdon Street and on 1 – 6 Radcot Street, would be prevented by underpinning, resulting in **no effect** on significance, but may have an archaeological impact, depth and extent to be determined following further monitoring and geotechnical investigations.
Mitigation Strategy	
Site preparation and shaft excavation	• Archaeological monitoring of geotechnical investigations to confirm predicted levels of natural geology and potential archaeological deposits • Archaeological monitoring during ground disturbance and excavation of the shaft in order to record any potential archaeological remains
Building works	• No built heritage mitigation required.

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Ordnance Survey revised edition 25":mile map of 1919
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Ordnance Survey 1:2500 scale map of 1970
Site visit carried out on 29th July 2010 and 16 April 2012

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Compiled by MOLA	Guillermo Molina-Burguera		02-08-2010
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5.6 Kennington Park permanent shaft and headhouse / traction sub-station

NORTHERN LINE EXTENSION PROJECT Historic Environment Site-Specific Worksheet	
Site Name:	**Kennington Park permanent ventilation shaft and headhouse / traction sub-station**
NGR	531540 177925
Borough	Greater London Borough of Lambeth
Address	Kennington Park (north side)
Outline of proposed works	• Establishment of work compound for deliveries, storage and general use. • Demolition of 20th century undesignated Kennington Park Lodge (**HEA 91**) • Construction of ventilation shaft and adjacent traction sub-station and headhouse in north-eastern corner of Kennington Park
Historic Environment Baseline	
Designated heritage assets	• Kennington Park, Grade II Registered Park (**HEA 31**) • The Bishops House, Grade II listed (**HEA 84**) • Gate piers to The Bishops House, Grade II listed (**HEA 85**) • 10 Kennington Park Place, Grade II listed (**HEA 86**) • 11 and 12 Kennington Park Place, Grade II listed (**HEA 87**) • 1–7 Agnes Place and Railings, Grade II listed (**HEA 88**) • Lodge at Entrance to Kennington Park, Grade II* listed (**HEA 89**) • St Mark's Conservation Area (local designation) • Locally listed First World War memorial in Kennington Park (**HEA 90**)
Non-designated heritage assets	• Projected line of Roman Stane Street • Projected line of medieval road connecting Kennington to Stockwell • Cottage/Lodge in north-east corner of Kennington Park (**HEA 91**)
Geology and topography	Ground level on the site lies at *c* 3.6m OD. The site lies on the Kempton Park Gravel Formation. A geotechnical borehole drilled in 2010 in the site (Halcrow Group Ltd July 2010, BH10), recorded the terrace gravels at *c* 1.5m OD (*c* 2.1m below ground level) overlaid by made ground.
Archaeological and historical summary	During the prehistoric period the site would have lain within woodland or open fields some distance from predictable resources of the Thames. The nature and extent of any Roman occupation in the area is not well-understood. Located immediately to the east of the Roman road leading to Chichester, it is possible that the site may have been occupied during this period. Otherwise, it is likely to have been within open land, or possibly woodland. In the early medieval period, the site may have been wooded and later located in arable or pasture land some distance from known settlements. During the later medieval period the site would have remained as part of Kennington common lands. During the early post-medieval period the site remained undeveloped common

	land until the mid-19th century when the site was included within the newly created Kennington Park. Rocque's map of 1746 shows the site in Kennington Common immediately to the east of Kennington Park Road. Horwood's map of 1799 and Greenwood's map of 1822−24 show no change. Stanford's map of 1862 shows the site within the newly developed Kennington Park, surrounded by increasingly dense development. The Ordnance Survey 1st edition 25":mile map of 1871, the 2nd edition of 1894, the 3rd edition of 1913 and the revised edition of 1919 show no change. The London County Council's Bomb Damage Map records substantial bomb damage around the park (LCC 1939-45, map 89). The Ordnance Survey 1:2,500 scale map of 1952 shows the construction of the gatekeepers lodge to the east, and no change within the site. The Ordnance Survey 1:2,500 scale map of 1970 shows no change.
Past impacts	The site was open ground until mid-19th century when it was laid out as an urban park. No past impacts other than garden works have been identified within the site.
Archaeological potential and statement of significance	Uncertain, possibly low. potential for remains of prehistoric to medieval periods. **Low to medium** significance depending on date, nature, extent and preservation.
Built heritage potential and statement of significance	The site is within Kennington Park, Registered Grade II and of **high** significance as a heritage asset. It is also within a Conservation Area, an asset of **very high** significance. The site lies within the setting of a number of heritage assets of **high to very high** heritage significance as well as a First World War memorial of **medium** significance. The cottage/lodge in the north-east corner of the park dates to the middle of the 20th century and is of **low** significance as a heritage asset.
Current Design	
Reference:	Based on information in ES Chapter 4: *Description of the NLE*, and the *Deposited Plans and Sections* drawings submitted as part of the TWAO Application.
Description	• Establishment of works compound *c* 28m x *c* 127m • Site preparation and removal of obstructions • Demolition of undesignated Lodge in north-eastern corner of Park • Piled retaining wall for shaft and sub-station • Piled foundations for sub-station • Excavation of a 13.5m diameter shaft down to *c* −21.5m OD (*c* 25.0m below ground level) • Excavation for sub-station to *c* –9.5m OD (*c* 13.0m below ground level) • Construction of headhouse in south-eastern end of the site, *c* 9.0 by 13.0m in plan, roof up to 12.2m OD
Impact	• Preparatory groundworks which extend beyond/beneath any modern made ground would truncate or remove entirely any archaeological remains in the area of impact. The significance of any remains affected would be reduced to **negligible**. • Construction of retaining wall will remove any archaeological remains within its footprint. The significance of any possible remains would be reduced to **negligible**. • Excavation for the shaft, sub-station and headhouse basement will remove any potential archaeological remains within their footprint. The significance of any remains affected would be reduced to **negligible**.

	• The cottage/lodge in the north-eastern corner of the park (low significance) would be demolished. • A section of the railings of the registered park will be removed during the construction period and later reinstated.
Mitigation Strategy	
Site preparation, retaining wall, shaft, tunnel and headhouse basement excavation	• Archaeological trenched evaluation to clarify potential within the shaft footprint, which could be combined with geotechnical investigations • Depending on the results of the evaluation, targeted archaeological excavation and/or an archaeological watching brief as the shaft is excavated downwards, in order to record any potential archaeological remains (preservation by record). It is possible that the evaluation establishes that no further work is necessary.
Building works	• The cottage/lodge to be demolished should be subject to an internal inspection to determine appropriate mitigation, likely to comprise a record at English Heritage Level 1 -2 prior to the commencement of works. • The removal of the park railings would be mitigated by their reinstatement, but their current state would also be recorded in the reporting on the cottage/lodge.

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Ordnance Survey 2nd edition 25":mile map of 1894

Ordnance Survey 3rd edition 25":mile map of 1914

Ordnance Survey revised edition 25":mile map of 1919

Ordnance Survey 1:2500 scale map of 1952

Ordnance Survey 1:2500 scale map of 1970

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Checked by MOLA	Hannah Pethen		16-08-2010
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Revised by MOLA	Christina Holloway/James Dixon		31-01-2013
Approved by MOLA	George Dennis		31-01-2013
Revised by MOLA	Christina Holloway/James Dixon		05-03-2013
Approved by MOLA	George Dennis		05-03-2013
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Approved by MOLA	George Dennis		20-03-2013

Revised by MOLA	Christina Holloway/James Dixon		10-04-2013
Approved by MOLA	George Dennis		10-04-2013
Revised by MOLA	Christina Holloway/James Dixon		11-04-2013
Approved by MOLA	George Dennis		11-04-2013

5.7 Harmsworth Street temporary shaft and worksite

NORTHERN LINE EXTENSION PROJECT Historic Environment Site-Specific Worksheet	
Site Name:	**Harmsworth Street temporary grouting shaft and worksite**
NGR	531525 178030
Borough	Greater London Borough of Southwark
Address	Harmsworth Street
Outline of proposed works	• Establishment of work compound for deliveries storage and general use • Construction of shaft 5.0m in diameter and 27.0m deep
Historic Environment Baseline	
Designated heritage assets	• The Bishop's House, Grade II listed (**HEA 84**) • Gate piers to The Bishop's House, Grade II listed (**HEA 85**) • 10 Kennington Park Place, Grade II listed (**HEA 86**) • 11 and 12 Kennington Park Place, Grade II listed (**HEA 87**) • 125 – 165 Kennington Road with attached railings and blind boxes, Grade II listed (**HEA 76**) • Kennington Park Road Conservation Area (local designation)
Non-designated heritage assets	• Projected line of Roman Stane Street. • Projected line of medieval road connecting Kennington to Stockwell. • 1 – 6 and 68 – 72 De Laune Street
Geology and topography	Ground level on the site lies at *c* 4.0m OD. The site lies on the Kempton Park Gravel Formation. A geotechnical borehole drilled in 2010 in De Laune Street, *c* 50m to the north of the site (Halcrow Group Ltd July 2010, BH9), recorded the terrace gravels at *c* 2.7m OD (*c* 1.3m below ground level) overlaid by made ground.
Archaeological and historical summary	During the prehistoric period the site would have been within woodland or open fields some distance from the resources of the Thames. The nature and extent of any Roman occupation in the area is not well-understood. Located immediately to the east of the Roman road leading to Chichester, it is possible that the site may have been occupied during this period. Otherwise, it is likely to have been within open land, or possibly woodland. In the early medieval period, the site may have been wooded and later in arable or pasture some distance from known settlements. During the later medieval period the site would have remained in open fields within or immediately to the north of Kennington common. During the early post-medieval period the site remained undeveloped. Rocque's map of 1746 shows the site in open fields within or immediately to north of Kennington common, to the east of Kennington Park Road. Horwood's map of 1799 shows the site in a cultivated field beside 'Back Lane' (now De Laune Street) within the developing street layout alongside Kennington Park Road and north of Kennington Common. Greenwood's map of 1822−24 and Stanford's map of 1862 show no change other than increasing development in the area and the creation of Kennington Park to the south of the site.

	The Ordnance Survey 1st edition 25":mile map of 1871 shows no change other than the development of a row of houses on the former open field immediately to the east of the site. The site was located at the junction of De Laune Street and Cross Street. The Ordnance Survey 2nd edition 25":mile map of 1894, the 3rd edition of 1914 and the revised edition of 1919 show no change other than the renaming of Cross Street as Harmsworth Street. The London County Council's Bomb Damage Map records 'Blast damage, minor in nature' and 'General blast damage, not structural' in the vicinity of the site (LCC 1939-45, map 89). The Ordnance Survey 1:2,500 scale map of 1952 and 1970 show no change.
Past impacts	The site was open ground until the late-18th century when it was incorporated into newly developed streets between terraced housing. No past impacts other than street surface and service works have been identified within the site.
Archaeological potential and statement of significance	Low potential for remains of prehistoric to post-medieval periods. **Low to medium** significance depending on date, nature, extent and preservation.
Built heritage potential and statement of significance	The site is within the setting of four listed buildings of **high** heritage significance. 125 – 165 Kennington Road is of **high** significance. 1 – 6 and 68 – 72 De Laune Street are of **low** significance.
Current Design	
Reference:	Based on information in ES Chapter 4: *Description of the NLE*, and the *Deposited Plans and Sections* drawings submitted as part of the TWAO Application.
Description	• Establishment of a work compound *c* 46m x *c* 10m • Site preparation and removal of obstructions • Retaining wall for shaft • Excavation of a 5.0m diameter shaft down to *c* −23.0m OD (*c* 27.0m below ground level)
Impact	• Preparatory groundworks which extend beyond/beneath any modern made ground would truncate or remove entirely any archaeological remains in the area of impact, reducing significance to **low** or **negligible**. • Excavation of the shaft will remove any archaeological remains within its footprint. The significance of any possible remains would be reduced to **negligible**. • The possible impact of settlement 125 – 165 Kennington Road, 1 – 6 and 68 – 72 De Laune Street, would be prevented by underpinning, resulting in **no effect** on significance but may have an archaeological impact, depth and extent to be determined following further monitoring and geotechnical investigations.
Mitigation Strategy	
Site preparation and shaft excavation	• Archaeological monitoring of geotechnical investigations to confirm predicted levels of natural geology and potential archaeological deposits • Archaeological monitoring during ground disturbance and excavation of the shaft in order to record any potential archaeological remains
Building works	• The proposed works do not impact upon any built heritage assets. • The underpinning of 125 – 162 Kennington Road would require listed building consent.
References	

Greater London Historic Environment Record (GLHER)

Greenwood, C, and Greenwood, J, 1827 'Map of London from an Actual Survey', reproduced in Margary 1982, '*Map of London from an Actual Survey' by C and J Greenwood, 1827,* Margary in assoc Guildhall Library, Kent

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5.8 Kennington station cross-passages

5.8.1 The impacts at Kennington Station are likely to be limited to the fabric of the Grade II listed station itself. No other heritage assets would be affected and the worksheet has therefore been abbreviated accordingly.

NORTHERN LINE EXTENSION PROJECT Historic Environment Site-Specific Worksheet			
Site Name:	**Kennington station cross-passages**		
NGR	531635 178285		
Borough	Greater London Borough of Southwark		
Address	Kennington Park Road		
Outline of proposed works	• New cross-passages at platform level		
Historic Environment Baseline			
Designated heritage assets	• Kennington Underground Station, Grade II listed (**HEA 106**)		
Historical summary	Constructed 1890–1925 for the City and South London Railway.		
Built heritage potential and statement of significance	Kennington Underground Station is of **high** significance		
Current Design			
Reference:	Based on information in ES Chapter 4: *Description of the NLE*, and the *Deposited Plans and Sections* drawings submitted as part of the TWAO Application.		
Description	• Addition of two passenger cross passages between the northbound platform tunnels and two cross passages between the southbound platform tunnels		
Impact	• The proposal will alter the fabric of the listed structure although the effect of the impact is thought to be **negligible**		
Mitigation Strategy			
Building works	• Listed building consent will be required for the proposed works, and depending on their extent may require historic building recording to an appropriate level (preservation by record).		
Approvals	**Name**	**Signed**	**Date**
Revised by MOLA	Christina Holloway/James Dixon		20-03-2013
Approved by MOLA	George Dennis		20-03-2013

6 Whole-route impacts

6.1 Ground settlement

6.1.1 Mitigation for ground settlement may have an archaeological impact, in terms of any grouting shafts opened from ground level and the resulting solidification of any archaeological layers in the area of impact. Although settlement contours have been defined, the location, extent and method of mitigation for ground settlement is yet to be determined. The effect on archaeology of solidification at depth cannot be mitigated, and consequently is not considered further in this assessment.

6.2 Building settlement

6.2.1 Mitigation for building settlement or damage to piled foundations (e.g. underpinning) may have an archaeological impact (i.e. affecting buried heritage assets). Table 1 summarises the known or likely archaeological potential in the vicinity of buildings identified as at risk, and the significance of any remains. Where piled foundations are present, any archaeological remains will already have been highly compromised, and potential is therefore generally low, but there may in some cases be fragmentary survival between the piles.

Table 1: Buried heritage assets which may be affected by settlement mitigation

West of Battersea station:
Structures potentially subject to mitigation: railway lines to/from Victoria Station, railway viaduct and Battersea Dogs and Cats Home.
Not in APA Open ground until creation of Battersea Park and New Road in the mid-19th century. Developed as Battersea Dogs Home in the late-19th century.
Low to moderate potential for isolated remains of prehistoric to medieval periods. **Low to medium** significance depending on date, nature, extent and preservation. Low to moderate potential for evidence of the construction of New Road and Battersea Dogs' Home, of **low** significance.

Between Battersea and Nine Elms stations:
Structures potentially subject to mitigation: South London Mail Centre, Post Office Way and Waterloo line viaduct.
Within APA for the archaeological and palaeoenvironmental potential of the Thames floodplain and the valley of an ancient tributary of the Thames. Open ground/market gardens until the 19th century. Mail Centre partly overlies the site of the 19th century Nine Elms Mill Pond channel, and later Gasworks.
High potential for palaeoenvironmental remains, of **medium** significance for the understanding of past landscapes. Uncertain potential for possible, previously unrecorded, prehistoric remains, of uncertain (potentially **medium**) significance. Low potential for localised and truncated remains of Roman to medieval periods. Uncertain significance depending on date, nature, extent and preservation. Low potential for remains of Gasworks

East of Nine Elms station:
Structures potentially subject to mitigation: Basil House and Adrian House, Wandsworth Road.
Not in APZ Market gardens possibly with buildings in the mid-18th century. Terraced houses/shops by the mid-19th century.
Low potential for remains of prehistoric to medieval periods. Uncertain significance depending on date, nature, extent and preservation. Low to moderate potential for fragmented remains of evidence of the construction of New Road and Battersea Dogs' Home, of **low** significance.

Structures potentially subject to mitigation: King's House, 9a–12a Victoria House, 70–105 Victoria Mansions, South Lambeth Road.
Within APZ for the archaeological potential of South Lambeth village. Market gardens and buildings in the mid-18th century. Some terraced houses by the mid-19th century; road re-aligned and built up with mansion flats by early-20th century.
Low potential for remains of prehistoric to medieval periods. Uncertain (probably medium to low) significance depending on date, nature, extent and preservation. Moderate potential for fragmented remains of 19th-century buildings, of low significance.

Dorset Road to Cottingham Road:
Structures potentially subject to mitigation: Beaminster House, Branksome House, Ibberton House, Horton House, Melbury House, Wareham House, Blandford House, Cottingham Road.
Not in APZ Large terraced houses built by the late-19th century.
Low potential for remains of prehistoric to medieval periods. Uncertain (probably medium to low) significance depending on date, nature, extent and preservation. Moderate potential for fragmented remains of 19th-century buildings, of low significance.

North-east of The Oval:
Structures potentially subject to mitigation: Lockwood House (part), Lohmann House, Kilner House, Sherwin House, Hornby House.
Not in APZ Terraced houses in the late-19th century
Low potential for remains of prehistoric to medieval periods. Uncertain (probably medium to low) significance depending on date, nature, extent and preservation. Moderate potential for fragmented remains of 19th-century buildings, of low significance.
Structure potentially subject to mitigation: Kennings Way Telephone Exchange.
Within APZ for archaeological potential in the vicinity of Roman road Large terraced houses by the late-19th century.
Moderate potential for remains of Roman period, potentially of medium or high significance, depending on nature, extent and preservation. Low potential for remains of prehistoric and medieval periods, of uncertain (probably medium to low) significance depending on date, nature, extent and preservation. Moderate potential for fragmented remains of 19th-century buildings, of low significance.

6.2.2 In all cases, settlement mitigation (localised underpinning or additional piling) would be likely to have a minor impact if any on buried asset significance, but since the extent and method for such work is yet to be determined, consequently the archaeological environmental effect and any appropriate mitigation will be assessed once this is known.

6.2.3 In addition to the settlement impacts outlined above, the scheme's alternative construction option would necessitate mitigation against settlement at the former Vauxhall Manor School Annexe and at 21 – 25, Cleaver Square, both Grade II listed. It is assumed that as with other built heritage assets assessed here, underpinning would constitute mitigation and therefore incur no further impact.

6.3 Utilities

6.3.1 Utilities vulnerable to critical settlement damage have been identified along the NLE route. Where mitigation comprises diversion or compensation grouting, there may be an archaeological impact. The nature and extent of such mitigation has yet to be determined. The archaeological environmental effect and appropriate mitigation will be assessed once this is known.

7 Cumulative Impacts

7.1 Buried heritage assets

7.1.1 Cumulative impacts of approved developments in the vicinity of the proposed route (URS 2012) are assessed in detail in the ES.

7.1.2 There is one known buried heritage asset shared between the Battersea Power Station and the NLE Battersea station sites, namely Southwark and Vauxhall Water Works, which includes the Grade II listed Battersea Water Pumping Station. However, the buried archaeological potential is for reservoirs and filter beds, which will have been largely removed by the construction of the Power Station. Therefore, the additional proposed construction of Battersea station is not considered a significant cumulative effect on the overall asset as it currently survives.

7.1.3 In combination, the Nine Elms Sainsbury's development and Nine Elms station would potentially affect any buried remains of the former 19th-century railway depot and marshalling yard, i.e. ancillary storage buildings and stables. Although of relatively low sensitivity, the implementation of an appropriate mitigation strategy (preservation by record) for the buried remains on both sites would allow a greater understanding and appreciation of the significance of the overall asset (the railway goods depot), therefore the net cumulative effect after mitigation would be Minor Beneficial, on the assumption that mitigation for both schemes includes publication and dissemination.

7.1.4 The remaining shared potential between the NLE and other nominated schemes is for general topographic environment, e.g. evidence of dry land uses such as agriculture on the Gravel Terrace, or for palaeoenvironments of prehistoric and later potential within the river alluvium. Similarly, there is a general shared potential for post-medieval industrial development and urbanisation. However, such past environments and land uses are widespread along the Thames and, therefore, this is not considered to be a significant cumulative effect.

7.2 Above-ground heritage assets

7.2.1 The Battersea station jetty site and Nine Elms Pier site both potentially affect riverside jetties, piers and associated industrial archaeology features. The implementation of an appropriate mitigation strategy (preservation by record) for the industrial archaeology on both sites would allow a greater understanding and appreciation of the significance of the former riverside industrial development which played an important part in the development of London as a world port. Therefore the net cumulative effect after mitigation would be minor beneficial, on the assumption that mitigation for both schemes includes publication and dissemination.

7.2.2 The remaining classes of built heritage asset potentially affected by the combined NLE and nominated sites relate to general industrial and commercial development as part of the 19th century urban expansion of London. Therefore, this generalised cumulative impact is not considered to be a significant effect.

7.3 Mitigation

7.3.1 Mitigation will be described in the Code of Construction Practice in Appendix O.

8 Conclusion and recommendations

8.1.1 The Battersea station site contains cranes on the Thames-side jetty included in the listing of Battersea Power Station. None of the other sites contain listed buildings. All sites except the Nine Elms station site fall within the setting of a listed building (around 50 in total) or of a conservation area. The north-eastern section of the NLE (southbound) crosses Kennington Park (registered Grade II by English Heritage under the Historic Buildings and Ancient Monuments Act 1953 within the Register of Historic Parks and Gardens for its special historic interest). Kennington Station is Grade II listed.

8.1.2 The northern sections of the NLE (northbound and southbound) cross two Archaeological Priority Zones (APZs) in Lambeth. The southern section (northbound and southbound) and the proposed conveyor for the construction of Battersea station cross an Archaeological Priority Area (APA) in Wandsworth.

8.1.3 Table 2 summarises the known or likely heritage assets within and immediately around the sites, their significance, and the impact of the proposals on asset significance.

Table 2: Impact upon heritage assets by site

Battersea station		
Asset	**Significance**	**Impact of proposals**
Moderate potential for remains of riverside structures and organic remains	Medium to high	Preparatory groundworks, dredging, construction of conveyor and works to existing jetty: asset removed locally or entirely. **Significance of asset reduced to negligible**
High potential for geoarchaeological and palaeoenvironmental remains	Medium	Preparatory groundworks, construction of conveyor and works to existing jetty, asset removed locally. **Significance of asset reduced to low or negligible, depending on extent**
Moderate to low potential for truncated buried remains of all periods, such as the bases of cut features and remains of the 19th-century reservoir and 20th-century railway depot	Low to medium	Preparatory groundworks, construction of conveyor and works to existing jetty, construction of retaining walls, excavation for ticket hall, station box and crossover box: asset removed entirely. **Significance of asset reduced to negligible**
Battersea Power Station, Grade II* listed (HEA 51)	Very high	**Potential impact on setting, assessed elsewhere**
Cranes and other curtilage structures	Very High	**Removal and/or alteration** **No impact on asset significance**
Battersea Water Pumping Station, Grade II listed	High	**Potential impact on setting, assessed elsewhere**
Battersea Gas Holders (HEA 59).	Low to medium	**Potential impact on setting, assessed elsewhere**
Whittington Lodge (HEA 104)	Medium	Incidental damage during underpinning. **Significance of asset unchanged or reduced to low although this is thought to be unlikely**
Railway viaducts east and west of Battersea Dogs and Cats Home	Low	Underpinning. **No impact on asset significance, but possible impact on underlying archaeological remains**
Embankment wall north of Battersea Power Station	Low	**No overall impact**

Other nearby undesignated buildings of heritage significance	Low to medium	**Potential impact on setting, assessed elsewhere**

Nine Elms station		
Asset	**Significance**	**Impact of proposals**
Uncertain, probably moderate to low potential for buried remains of the prehistoric period	Low to high	Preparatory groundworks, construction of retaining walls, excavation for the station box: asset removed entirely. **Significance of asset reduced to negligible**
Low potential for buried remains of the Roman and medieval periods	Low to high	Preparatory groundworks, construction of retaining walls, excavation for the station box: asset removed entirely. **Significance of asset reduced to negligible**
Moderate potential for geoarchaeological and palaeoenvironmental remains	Medium	Construction of retaining walls, excavation for the station box: asset removed locally. **Significance of asset reduced to low or negligible, depending on extent of deposits**
Moderate potential for buried remains of 19th and 20th-century buildings	Low	Preparatory groundworks, construction of retaining walls, excavation for the station box: asset removed entirely. **Significance of asset reduced to negligible**
Standing mid 19th-century and 20th-century industrial buildings	Low to medium	Partial demolition of existing buildings. **Significance of assets reduced to negligible**
Adrian House and Basil House	Low	Underpinning. **No impact on asset significance, but possible impact on underlying archaeological remains**
Victoria Mansions	Low	Underpinning. **No impact on asset significance, but possible impact on underlying archaeological remains**
Railway viaduct west of the site	Low	Underpinning. **No impact on asset significance, but possible impact on underlying archaeological remains**

Kennington Green permanent shaft and headhouse		
Asset	**Significance**	**Impact of proposals**
High potential for buried remains of 20th-century works and moderate potential for remains of mid 19th-century houses	Low	Preparatory groundworks, construction of retaining walls, excavation for shaft, headhouse and connecting tunnel: asset removed locally or entirely. **Significance of asset reduced to negligible**
Uncertain, probably low, potential for remains of the prehistoric to medieval periods	Low to medium	Preparatory groundworks, construction of retaining walls, excavation for shaft, headhouse and connecting tunnel: asset removed entirely. **Significance of asset reduced to negligible**
Within a Conservation Area designated by the local authority	Very high	Worksite, demolition of Distillery wall, shaft excavation and construction of headhouse and water tank. **Potential impact on setting, assessed elsewhere**
Grade II listed buildings on Kennington Road and Montford Place within *c* 150m of the site	High to very high	Shaft excavation and construction of headhouse. **Potential impact on setting, assessed elsewhere**

Industrial buildings behind 373 Kennington Road	Low	Underpinning. **No impact on asset significance, but possible impact on underlying archaeological remains**
Post-1945 'Gatehouse' wall of Beefeater distillery	Negligible	Demolition **Negligible impact on asset significance. Potential impact on setting of nearby assets, assessed elsewhere**

Radcot Street temporary northbound grouting shaft		
Asset	**Significance**	**Impact of proposals**
Low potential for remains of the prehistoric to post-medieval periods.	Low to medium	Preparatory groundworks and shaft excavation: asset removed locally or entirely. **Significance of asset reduced to low or negligible**
Within a Conservation Area designated by the local authority	Very high	Shaft excavation and associated works. **Potential impact on setting, assessed elsewhere**
Grade II listed buildings on Kennington Park Road and Cleaver Square within *c* 100m	High	Shaft excavation and associated works. **Potential impact on setting, assessed elsewhere**
Undesignated 19th and 20th-century buildings/structures adjacent to the site	Low to medium	Shaft excavation and associated works. **Potential impact on setting, assessed elsewhere**
5 – 9 and 8 – 14 Ravensdon Street	Low	Underpinning. **No impact on asset significance, but possible impact on underlying archaeological remains**
1 – 6 Radcot Street	Low	Underpinning. **No impact on asset significance, but possible impact on underlying archaeological remains**

Kennington Park permanent ventilation shaft and headhouse / traction sub-station		
Asset	**Significance**	**Impact of proposals**
Uncertain, possibly low, potential for buried remains of the prehistoric to medieval periods	Low to medium	Preparatory groundworks, construction of retaining walls, excavation for shaft and sub-station: asset removed entirely. **Significance of asset reduced to negligible**
Within a Conservation Area designated by the local authority	Very high	Worksite, shaft excavation and construction of headhouse **Potential impact on setting, assessed elsewhere**
Grade II* and Grade II listed buildings/structures within *c* 100m of the site	High to very high	Shaft excavation and construction of headhouse **Potential impact on setting, assessed elsewhere**
Kennington Park, Grade II Registered Park	High	Shaft excavation and construction of a headhouse over the shaft. **Potential impact on setting, assessed elsewhere**
Railings of Kennington Park	High	Partial removal followed by reinstatement **No impact on asset significance**
First World War memorial in Kennington Park	Medium	Shaft excavation and construction of headhouse **Potential impact on setting, assessed elsewhere**

Cottage in north-eastern corner of Kennington Park and nearby undesignated buildings of heritage significance	Low to medium	Shaft excavation and construction of headhouse Demolition of cottage/lodge **Potential impact on setting, assessed elsewhere**

Harmsworth Street temporary grouting shaft and worksite		
Asset	**Significance**	**Impact of proposals**
Low potential for remains of the prehistoric to post-medieval periods.	Low to medium	Preparatory groundworks and shaft excavation: asset removed locally or entirely. **Significance of asset reduced to low or negligible**
Grade II listed buildings within *c* 100m	High	Shaft excavation and associated works. **Potential impact on setting, assessed elsewhere**
Nearby undesignated buildings of heritage significance	Low to medium	Shaft excavation and associated works. **Potential impact on setting, assessed elsewhere**
1 – 6 and 68 – 72 De Laune Street	Low	Underpinning. **No impact on asset significance, but possible impact on underlying archaeological remains**
125 – 165 Kennington Road	High	Underpinning. **No impact on asset significance, but possible impact on underlying archaeological remains**

Kennington station cross-passages		
Asset	**Significance**	**Impact of proposals**
Kennington Underground Station	High	Addition of cross passages **No impact on asset significance**

8.2 Further work

8.2.1 Mitigation is described in the Code of Construction Practice (CoCP) in Appendix O.

8.2.2 It is recommended that preliminary site specific field evaluation is carried out prior to the construction of the stations, ventilation shafts and other groundworks. This could take the form of archaeological trenched evaluation in order to clarify the presence, nature, extent, survival and significance of any buried heritage assets that might be present. This could be combined with geotechnical investigations.

8.2.3 The results of the evaluation would allow the local planning authority to formulate an appropriate mitigation strategy, if required. Currently no remains of very high significance warranting preservation *in situ* have been identified by this desk-based study. The mitigation might comprise targeted archaeological investigations if significant remains were identified, e.g. excavation and/or watching brief, as the shaft is excavated downwards. This would achieve preservation by record. These could be carried out under an approved written scheme of investigation (WSI) as part of a standard planning condition.

8.2.4 It is recommended that structures due to be demolished as part of the construction of Nine Elms Station and the Kennington Park headhouse are recorded to English Heritage Level 1 – 2 (drawings, photography and a written record of the building as appropriate) prior to the commencement of works, with the level of recording to be determined by internal inspection. The recording of the cottage/lodge in the north-east corner of Kennington Park should include the park railings surrounding it, as far as they are being removed for construction (prior to subsequent replacement).

8.2.5 The scheme includes a number of minor works to listed buildings; 362 – 366 Kennington Road, 125 – 165 Kennington Park Road, and Kennington Underground Station. All of these works will require separate assessment for the purposes of obtaining listed building consent.

8.2.6 Predicted noise levels of the proposed development would need to be confirmed and updated following further surveys at a more detailed design stage, therefore any physical noise mitigation to Listed and locally listed buildings, such as secondary glazing, will be identified via the necessary notifications to EH and Local Authorities as specified in the CoCP.

9 Gazetteer of known historic environment assets

9.1.1 The table below represents a gazetteer of known archaeological sites and finds within a study area *c* 250m to either side of the NLE. The gazetteer should be read in conjunction with Fig 2.

Abbreviations
AOC – AOC Archaeology Group
CA – Compass Archaeology
CgMs – CgMs Consulting Group
COT – Cotswold Archaeology
GLHER – Greater London Historic Environment Record
MoLAS – Museum of London Archaeology Service (now named MOLA)
NHLE – National Heritage List for England
OAU – Oxford Archaeology Unit
PCA – Pre-Construct Archaeology
SAEC – Southwark Archaeological Excavation Committee
SAS – Sutton Archaeological Services
SLAEC - Southwark and Lambeth Archaeological Excavation Committee
SLAS - Southwark and Lambeth Archaeological Society
WA – Wessex Archaeology

HEA No.	Description	Site code/ GLHER/ NHLE No.
1	**Post Office Way, Ponton Road, Nine Elms Lane.** Archaeological watching brief by PCA on a geotechnical investigation in 2008. Alluvium above natural gravels or, in the south of the site, brickearth, was overlain by 16th/17th century agricultural soil. Towards the centre of the site the foundations and a basement or cellar, probably part of the 19th century brewery that was situated in the area, were recorded above the earlier deposits. On the north-east edge of the site was an undated structure cut into the natural gravel and sealed by 18th/19th century made ground, whilst towards the north side an 18th/19th century well or cesspit was recorded. Modern made ground sealed the site.	PNO08 MLO100457 MLO100463
2	**143–161, Wandsworth Road, SW8.** Watching brief by COT in 2008 revealed a wall foundation and a doorstep and a possible flower bed relating to 18th-century gardens known to have been situated within the site. Natural gravels were noted overlain by 20th-century makeup beneath a concrete floor.	WRL08
3	Site of a medieval bridge, also called **Barton Bridge**, which carried Merton Road over the Effra river.	MLO11393
4	**77–79, Kennington Park Road, SE11.** Fieldwork by PCA in 2010. Natural gravels were sealed by subsoil, in turn overlaid by levelling layers sealed by garden soil. A 19th century brick soakaway and a brick drain feeding into it were recorded, sealed by 19th century garden soils and made ground.	KEP10
5	**117, Kennington Park Road, SE11.** Site code allocated for fieldwork by AOC in 2012. No further information available.	KPK12
6	**28–34, St Agnes Place, Kennington, SE11**. Site code allocated for fieldwork by PCA in 2011. No further information available.	AGN11
7	The location of a 17th century windmill or post mill, with weatherboarded body and four common sails, still extant 1814 but recorded as demolished by 1828.	MLO12012
8	Watermill fed from an extensive millpond, which partially survived in 1966.	MLO12013
9	Two smockmills, corn, marked on a number of 17th-century maps and pictures “between the red house and the east end Nine Elms lane”.	MLO13251
10	**144–150, Old South Lambeth Road, Lambeth, SW8.** WA evaluation in 2004 revealed extensive truncation from late 19th-century building and 20th-century fuel tanks. In one area earlier dumps and soil deposits of 19th-century date were located.	LBO04

HEA No.	Description	Site code/ GLHER/ NHLE No.
11	**33, Stannary Street, Lambeth, SE11.** WA watching brief in 2004 revealed severe modern truncation. A small ditch dating to the early post-medieval period contained a redeposited sherd of Roman pottery. The site was probably used as market gardens.	SSY04
12	Site of medieval/post-medieval village of South Lambeth.	MLO13539
13	In the Thames Channel, the approximate findspot, probably in the early 20th century, of a Neolithic flint axe with flat underside. Surface well chipped.	MLO14603
14	Roman lead coffin and four skeletons found 1794 in Battersea Fields. Coffin (ornamented with scallop shells and cable mouldings) melted down and skeletons lost.	MLO17077
15	Roman bronze coin of Antonius Pius minted *c* AD 144 found *c* 1857.	MLO18527
16	Pound shown on map of 1681 as noted on the GLHER.	MLO23062
17	Site of a vinegar brewery noted on the GLHER.	MLO24766
18	Site of the 'great house' bought by Caron in 1602 with dairy house and 70 acres.	MLO2737
19	Site of Caron or **Caroun House** built by Sir Charles Blicke on site of former Caron mansion.	MLO2738
20	Mansion known 1656, house of John Tradescant, adjoined Ashmole's house.	MLO30375
21	**St. Mark's Church, Clapham Road, and burial ground.** The church was built in 1822–4, and damaged during World War II, since restored. The burial ground of the church was noted in Mrs Basil Holmes's 1896 survey of London's Burial Grounds as closed, full of tombstones, but neatly kept. Site of the chance find of a primary flint flake, rolled and slightly stained, noted in the GLHER.	MLO7763
22	Part of possible alignment of Roman 'London-Brighton way'	MLO8095
23	Site of a manor house noted on the GLHER. A building known as 'Manor House' is shown on the Ordnance Survey 1st edition map of 1874, and the site of a 'manor house' is shown on subsequent Ordnance Survey maps and noted in the GLHER: no further details are given, and no medieval house has been identified from other sources.	MLO3284 020779
24	House with barn, known in 1592	MLO4094
25	Gallows on Kennington Common known 1675.	MLO4063
26	Post-medieval well. Also called Fauxwell, Foxhall Well. Still in use in 1856.	MLO4100
27	Site of house named on map of 1636 as "Mr Carpenter's house".	MLO4138
28	Site of the **Wood Bridge**, known 1592.	MLO4146
29	Site of turnpike gate marked on map of 1785.	MLO4148
30	**37, Clapham Road (opposite), Lambeth, SW9.** SLAEC watching brief in 1974. Sections created during roadworks along Clapham Road were examined, and may have indicated the presence of Roman Stane Street.	MLO4182 CPU74
31	Site of **Hasardes Bridge**, a medieval timber bridge apparently often confused with Martins Bridge nearby, noted in the GLHER.	MLO4315
32	**Kennington Park**. Designated as Grade II in the English Heritage Register of Parks and Gardens of Special Historic Interest. Public park owned and managed by the London Borough of Lambeth. In 1852 an Act of Parliament was passed which enabled *c* 7ha, the greater part of Kennington Common, to be enclosed. Laid out by James Pennethorne in 1852–54, it became known as Kennington Park. In 1854 the park was opened to the public and in 1887 it was transferred to the Metropolitan Board of Works The main 19th-century park had a central area of lawns, enclosed by paths, lined with planes, and shrubbery and trees along most boundaries. Mature trees in the park now include notable planes, and thorn, acacia, holm oak, ash and chestnut. Twin cottages facing Kennington Park Road designed in 1851 by Henry Roberts for display at the Great Exhibition, were re-erected as lodges in Kennington Park. The 1921 addition of 2ha to the south-east allowed creation of an enclosed formal garden, with pergola and symmetrical scheme of roses, borders and bedding, and a swimming pool, with extensive playground further to south-east. The 1970's addition of 4ha to the south-east includes recreational and sport facilities, including all-weather pitches. The detached triangle of land to south-west of the park was re-landscaped 1983/1984, with paving and shrubbery round the mature trees, and a central fountain basin. The designation is considered to include the park railings.	1000816 MLO59415
33	**South Lambeth Bridge** (post-medieval) noted in the GLHER.	MLO77535

HEA No.	Description	Site code/ GLHER/ NHLE No.
34	**Kennington Lido, Kennington Park, Brixton Road, Camberwell New Road, Lambeth, SE11.** SLAEC watching brief in 1977 found evidence of natural topography only.	MLO63149 L5/77
35	**South Lambeth Road, Thorne Road, Mawbey Street, Brough Street, Wilcox Road, SW8.** SLAEC watching brief in 1977 found evidence of natural topography only.	MLO63167 L61/77
36	**55–77, South Lambeth Road, SW8.** SLAEC watching brief in 1977 revealed modern disturbance only.	MLO63205 L131/77
37	**Wisden House, Ashmole Estate, Ashmole Street, Lambeth, SW8.** SLAEC watching brief in 1978 revealed evidence of natural topography only.	MLO63227 L199/78
38	**Mawbey-Brough (Phase 2A), South Lambeth Road, Rosetta Street, Wilcox Road, Wheatsheaf Lane, Lambeth SW8.** SLAEC watching brief in 1978 noted a cut feature probably of post-medieval date, as well as evidence for natural topography.	MLO63235 L212/78, L212/79
39	**Eastern Triangle Site, Wandsworth Road, Lambeth, SW8.** SLAEC watching brief in 1981 noted a shallow trench of apparently 17th- or 18th-century date.	MLO63258 L436/81
40	**Old Town Hall (trench outside).** SLAEC watching brief in 1979 found evidence of natural topography only.	MLO63263 L462/79
41	**Sainsbury's Nine Elms, 66–68 Wandsworth Road, SW8.** MoLAS evaluation in 1993: natural gravels were not reached and the deep sequence of mid to late 19th-century deposits were therefore probably infill of quarry pits.	MLO63890 SNE93
42	**Cringle Street, SW8.** SAEC watching brief in 1970 at Cringle Dock recorded sloping layers of silt and clay revealing random timbers, and the remnants of a boat.	CNG70
43	**106, Clapham Road, Lambeth, SW8.** SAS watching brief in 1998 recorded brick rubble, overlaid by tarmac.	MLO73796 CPO98
44	**Queenstown Road, Wandsworth, SW8.** A watching brief by SAS in 1998. The site is close to the railway viaducts between the Battersea Railway Station and Victoria Station. Red brick walls were found of a non-domestic/light industrial structure. No evidence was found for the foundations of a pier supporting the railway viaduct that lasted until the post-war period. The discovery of pre-1840 layers has been recognised and more remains may survive albeit truncated beneath these layers. Alluvial deposits found in the north of the site. Possibly the southern side of known palaeochannel to the west.	MLO75475, MLO77623 QTR98
45	**Battersea Power Station and South Lambeth Goods Yard.** Archaeological and geotechnical evaluation of 37 test pits and 4 archaeological test pits, and monitoring of geotechnical work, by SAS in 1997. Construction of the former reservoirs and subsequent power station had removed archaeological remains in most areas, but significant exceptions lay to the south and south east of the power station where the natural gravel terraces were found to have survived up to 3.0m OD. The eastern test pits revealed worked alluvial soils probably derived from the pre-1862 market gardens of the area. Boreholes produced evidence for a possible ancient river channel running west-east parallel to the Thames that silted up and allowed peat formation, or the maximum southern extent of the River Thames at this point. Environmental evidence of the prehistoric to late-Saxon period was recovered.	MLO75505 KTS97
46	**271–275, Kennington Lane, Lambeth, SE11.** OAU evaluation in 1998: Natural gravels were recorded but there had been substantial disturbance of the site, including modern services and a basement. Surviving walls are most likely to have been associated with the late 19th-century school buildings and Drill Hall.	MLO78342 KNN98
47	**Tideway Industrial Estate, Nine Elms Lane, Battersea, SW8.** Fieldwork site code allocated to PCA. No further information available at time of reporting.	TID11 TED11

HEA No.	Description	Site code/ GLHER/ NHLE No.
48	**Tideway Industrial Estate, Nine Elms Lane, Battersea, SW8.** MOLA evaluation and watching brief in 2012 on the site of a new access road, comprising two ground investigation trenches to locate the structure of a 19th-century-gas holder, 21 geotechnical test pits and 13 geoarchaeological boreholes. A series of deposits was repeated across the site: river gravels at the base of the sequence overlain by alluvial deposits and silty soils, the latter apparently formed naturally during the medieval and early post-medieval periods. These were sealed by post-medieval made ground. The foundations of 19th-century terraced houses were uncovered in the northern part of the site and in the western part of the site a deep cut feature filled with brick demolition deposits is likely to have derived from the demolished late 19th-century gas holder.	PRD12
49	Market garden. A 19th-century horticultural market devoted to the production of fruits.	–
50	Early 20th-century goods depot of the South Western Railways, renamed in mid 20th century as **South Lambeth Goods Depot**, shown in historic maps.	–
51	**Oval Cricket Ground (Vauxhall End stands), Kennington Oval, SE11.** CgMs standing building recording in 2004. The structure comprised five different stands arranged in a U-shape erected between the late 19th to early 20th century and the 1980s. The Surridge Stand, built c.1895 – 7,, comprised open concrete terraces built along original late 19th-century earth banks, formed by the excavated earth from the Vauxhall Creek and completed in 1880. The Gover Stand was a rectangular steel (RSJ) structure clad in red brick built between 1916 and 1938 with open concrete steps fitted with modern seats. Originally an open structure, it was later clad in brick and the spaces underneath utilised for bars and services. The Fender Stand - the most architecturally expressed in the group - was a rectangular steel structure clad in red brick, built between 1916 and 1938 (probably 1920s). It had a canopy roof supported on an RSJ structure with concrete steps below, fitted with modern seats. The Vauxhall Chalet Complex comprised a modern flat roofed rectangular steel structure clad in metal panels and internally divided into viewing rooms or boxes built over the earlier 1950's Jardine Stand which was visible below and comprised terraced concrete steps similar to the Surridge Stand. The Peter May Stand was a modern (1950s) low, open concrete terrace structure with brick panels at the back forming utility rooms. Exits were integral to the structure and spaced at regular intervals along the stand, providing access to the stands at ground level. The Surridge Stand and the adjacent 1930s Hobbs Gate are locally listed.	OVV03
52	**33, Clapham Road (outside), SW9.** An SAEC watching brief in 1966 on a roadwork trench on the predicted alignment of Roman Stane Street: it revealed no trace of the road.	CMD66
53	The location of **T. & W. Farmiloe's Nine Elms Lead Works**, established in 1886 which became paint works in the early 20th century.	MLO64086 800014
54	**Southwark And Vauxhall Water Works Company Pumping Station (Former), Battersea Water Works, Cringle Street, SW8.** Standing building recording carried out by CgMs in 2003 on buildings dating from 1839–40 to 1856, with additions to *c* 1930. The engine house (**HEA 57**) is Grade II Listed.	BWK03
55	**Former burial ground and site of St. George's Church, Nine Elms Lane.** The church was built in 1828, altered and extended in 1874 and seriously damaged during World War II. It was closed in 1953 following bomb damage in 1940 and destroyed by fire in 1960. The burial ground of the church was noted in Mrs Basil Holmes's 1896 survey of London's Burial Grounds as closed, and very neglected, with few gravestones.	–

HEA No.	Description	Site code/ GLHER/ NHLE No.
56	**Kennington Palace.** Documents suggest that there would have been fairly substantial buildings by the early-14th century, including a hall, chambers, kitchen stable gatehouse and gardens. In 1337 it was granted by Edward III to Edward, Earl of Chester and Duke of Cornwall, commonly known as the Black Prince, who took up residence in the manor house, and appears to have carried out extensive rebuilding. The buildings were demolished in 1531 by Henry VIII who instructed that the materials should be reused in the building of his new palace at Whitehall. In order to transport the stone and timber a dock was used at 'Faux Hall' in order to load barges. This lay near Vauxhall Bridge. Excavation by SLAS and SAEC in 1965–8, in advance of development. A large number of trenches were dug in an area bounded by Sancroft Street, Cardigan Street and Kennington Road. Five periods of occupation were recorded from the 14th to 18th centuries. These included a substantial range of manorial buildings of the mid 14th century running south-east to north-west, to the south-west of St Anselm's Church and Vicarage. Two small brick manor houses post-dated the demolition of 1531, one of which was superseded by evidence of a Long Barn in the southern part of the site close to Kennington Road.	MLO53647 090015/05 MLO56173 MLO56444 090015/03/002 090015/04/001
57	**Battersea Water Pumping Station (Southwark and Vauxhall Water Works), reservoirs and filtering-beds** Operational *c* 1839–1925. The boiler house, stores and workshops, standpipe tower and chimney stood to the rear of the pumping station. Significant remains of early, pioneering engine houses, including the engine house of the first Cornish engine to be purpose-built for a waterworks and the engine house of the largest Cornish engine ever built, the '112'. The reservoir and filter beds of the waterworks were sold by the Metropolitan Water Board for Battersea Power Station. Battersea Water Pumping Station. Grade II listed. Now disused. Extended two bays in 1846, and lower west end 1856 by John Aird, for the Southwark and Vauxhall Water Company.	MLO97952 MLO65779–84 MLO19935 MLO93826 1226087
58	**Battersea Power Station, Cringle Street SW8.** Grade II* listed building Former electricity generating station. Built in 2 principal phases: 1929–35 and 1937–41, completed 1955. Built by the London Power Company to the design of Leonard Pearce, Engineer in Chief to the LPC, CS Allott & Son Engineers: the architects were J Theo Halliday and Sir Giles Gilbert Scott. Steel frame clad in brown Blockley bricks laid mainly in English bond; reinforced concrete roofs; that to the boiler houses currently (2005) missing; pre-cast concrete chimneys; metal-framed Crittall windows. Standing building recording of the jetty and cranes at Battersea Power Station was carried out by CgMs in 2005. The jetty represents a purpose built, utilitarian, early 20th-cewnturty industrial structure, fitted with industrial steel cranes. It comprised a rectangular concrete slab which served as an elevated platform on the Thames, and occupied much of the site's river frontage, being approximately 130m long and set approximately 15m from the river wall. It was connected to the shore by a steel footbridge or ramp structure, set centrally towards the east of it. To the east of the jetty was an associated timber dolphin. Two travelling steel jib cranes and hoppers were located at the W end of the jetty. The jetty, also known as the Coaling Jetty was constructed in 1929–30 of modular reinforced poured or cast concrete frames, used repetitively to form its four sections and 17 bays. Within each section extensive horizontal and diagonal concrete braces were inserted, together with a protective wire mesh structure to prevent floating debris damage and concrete gangways for access. The south side of the jetty (barge bed) included a mass concrete retaining wall at its lower levels. The design of the jetty was partly determined by the position and form of the cooling water intakes (serving the power station) and discharging points and the screening chambers. Coal, for fuelling the boilers, was delivered from the North-East coast by purpose built barges and was hoisted by the two extant jetty-mounted cranes, from where it was transferred via conveyors to the large coal store located between the river and power station building, or alternatively directly to the internal coal bunkers of the boiler house.	1357620 BPX05
59	**Unlisted Battersea Gasholders**	–
60	**Kennington Green** Designated under the London Squares Preservation Act, 1931.	–

HEA No.	Description	Site code/ GLHER/ NHLE No.
61	**3 and 7 – 25, Montford Place** Grade II listed. Terrace, *c* 1780. Built of stock brick in Flemish bond with stone parapets, slate roofs and brick chimney stacks. Three Storeys, two windows each. Mainly eight-pane sashes to second floor but No 11 has 20th-century casements and Nos 13, 15, 17, 19, 21 and 23 have mid-19th-century, six-pane sashes with horns. First floor has two tall 12-pane sashes mainly with horns and ground floors have three round-headed arches with impost blocks, two containing six-paned sashes and the other containing door with semi circular fanlight. No 3 has a fanlight with ogee glazing bars and six- panelled door, No 19 has a Regency three-panelled door and No 25 has a seven-panelled door and retains spear railings. Nos 1 and 5 originally part of the terrace were rebuilt in the 20th century and are not of special architectural or historic interest. For 1 and 5 see **HEA 107**	1263532
62	**362, 364 and 366, Kennington Road** Grade II listed. Symmetrical early 19th century terrace, each three storeys, attic and basement; two:three;two windows. Central house projects slightly. Slated mansard with dormers, No 366 with added pediment. Gauged flat brick arches to sash windows, mostly with glazing bars. No 362, ground floor windows have patterned cast iron guards; ten steps to four-panel door in stuccoed doorcase of fluted pilasters, plain architrave and keyblock with mask. No 364 has modern door in similar surround. No 366 has one storey and basement left addition with modern door in similar surround; and projecting left bay. Height of modern steps to door terrace. Included for group value in spite of alterations.	1358291
63	**356, Kennington Road** Grade II listed. Early 19th century house of three storeys, attic and basement, three windows. Stock brick with stucco frieze, cornice and blocking course (with later brick coping). Slated mansard with round arched dormers. Gauged brick window arches, round on ground floor. First and ground floor arcaded, the latter with impost string. Ground floor windows sashes with radial glazing, first floor long casements to cast iron balconies, plain sashes above. Twelve steps, with original walls and railings, to six panel door with feathered capitals to attached fluted columns, plain head and fanlight.	1080361
64	**354, Kennington Road** Grade II listed. Early 19th century house of three storeys, attic and basement, two windows, with one storey right entrance bay shortly afterwards raised to full height on recessed plane. Stock brick with stone-coped parapet and slated mansard with modern but seemly dormer. Finely gauged brick arches, flat on second floor to wide, replaced sashes with glazing bars, round on first floor to similar windows with plaster fan-patterned tympana and patterned cast iron guards. Elliptical ground floor arches with plain plastered tympana; and segmental basement arches holding modern garage doors. In set back right bay, flat arches to original sashes with bars. Twelve steps to six-panel door between paired engaged fluted columns with feathery capitals. Mask on keystone and guilloche moulding on impost blocks of gauged brick round arch over fanlight.	1080360
65	**350 and 352, Kennington Road** Grade II* listed. Early 19th century handsome pair, each three storeys, attic and basement, three windows with slightly projecting one storey entrance link, that of No 325 built up later on a recessed plane. Stock brick, stucco entablature and blocking course. Slated mansard with round-arched dormers. Gauged brick arches to windows; sashes with glazing bars, round-headed on ground floor with radial glazing; long first floor casements to full width ornamental cast iron balcony. Arcaded ground and first floors, latter with paterae in tympana and rams' heads on imposts; ground floor with keystone masks and guilloche moulded impost band. Doors of six: panels have paired engaged fluted columns with feathering capitals. No 350 has patterned radial fanlight. Tall flights of steps.	1186098
66	**348, Kennington Road** Grade II listed. Late 18th century house of four storeys and basement, two windows, and one-storey entrance link built up to full height in later 19th century. Stock brick with renewed parapet coping. Stuccoed ground floor with banded rustication. Gauged brick window arches. First floor long 19th century casements to ornamental cast iron balconies. Other windows modern casements or replaced sashes. Twelve steps to new door with ornamental head, patterned radial fanlight and female mask on keystone. Original handrails. Included for group value.	1080404

HEA No.	Description	Site code/ GLHER/ NHLE No.
67	**346, Kennington Road** Grade II listed. Probably late 18th century. Three storeys, attic and basement, two windows. Stucco with incised lines and parapet front. Tiled mansard with dormers. 19th century casements, those on first floor long to balcony with ornamental railings. Ground floor rustications form voussoirs to sash windows and round arched doorway. Modern door between engaged columns with feather capitals. Mutuled cornice head and fanlight with vertical bars. Eleven steps. Included for group value.	1358270
68	**The Lycee, Stannary Street, formerly the Vauxhall Manor School Annexe** Grade II listed. 1897–1900 dated on left pediment. Late and romantic example of LCC Board School architecture. Large, symmetrical building of seven sections. Central five-bay block of three tall storeys under hipped tiled roof having three tiny lucarne-like aria stone. Flanking six-storey staircase towers have ogee pyramidal roofs rising to terrace with octagonal drum and tall dome with spike and vane. Intermediate five-storey sections, with four closely-set windows under scalloped parapet, lead to pedimented end pavilions of three tall storeys with ornamental panelling in tympanum. Now divided into flats.	1358267
69	**Old Town Hall (Church of England Children's Society), 367, Kennington Road** Grade II listed. Formerly Lambeth Vestry Hall, now private offices. Classical building of mid 19th century. Two storeys and sunk basement, nine windows in three three-bay sections. Slightly projecting centre section has tetrastyle Tuscan portico in antis with modillion cornice and pediment. Greyish brick. Outer sections have paired pilaster bay divisions with entablatures to each floor; and arcaded ground floor. Sash windows with margin lights, mostly in moulded architraves; console bracketed cornices and pediments on ground floor centre. Modern central door in surround of vermiculate rusticated columns, Doric entablature and thin (later?) pediment in an outer surround also with vermiculate rustications. Wrought iron area railings (some replaced) with bulb finials. Building is T-shaped and central back projection has bowed end.	1080399
70	**328, Kennington Road** Grade II listed. Late 18th century house of three storeys and basement, two windows. Stock brick with stone-coped parapet. Stuccoed with incised lines. Gauged flat brick arches to sash windows. Narrow 19th century four-panel door with rectangular fanlight. Included for group value.	1299377
71	**324A and 326 Kennington Road** Grade II listed. Late 18th century pair, each three storeys, attic and basement, two windows. Stock brick, pedimented front with stone cornices and first floor cill band; stuccoed basement. Lunette with patterned glazing in pediment. Gauged brick arches, round on ground floor, to sash windows with glazing bars (some replaced). Eight steps to six-panel doors with cornice head and patterned radial fanlight. Doorcase of fluted pilasters, console bracketed cornices and open pediment.	1080403
72	**320 and 322, Kennington Road** Grade II listed. Late 18th century pair, each three storeys and basement, two windows. Stock brick with stone coped parapet. Gauged brick arches to sash windows with glazing bars, round-headed on ground floor in round-arched recesses. Narrower recesses hold six-panel doors, with cornice head and patterned fanlight, up seven steps with cast iron handrails, No 320 replaced.	1299370
73	**318, Kennington Road** Grade II listed. Part of terrace, *c* 1790–1820. Built of stock brick in Flemish bond with mansard roof and end brick chimneystacks. Three storeys and attics. Two windows. Attic has 20th century nine-pane flat- roofed dormer. Stone coping. Second floor has 12-pane sashes with flat voussoirs. First floor has 12-pane sashes with flat voussoirs. Ground floor has right side round-headed arched windows in reveals. Left side round-headed doorcase with semi-circular fanlight and 20th century six-panelled door. Stone panel to right above ground floor window reads "Kennington Green". 20th century area railings.	1262862

HEA No.	Description	Site code/ GLHER/ NHLE No.
74	**164 – 170 and 170A, Kennington Park Road** Grade II listed. Late 18th or early 19th century terrace with alterations. Each house three storeys and basement, three windows. Stock brick with stuccoed incised basement and ground floor to first floor cills. No 164 has flat gauged brick window arches; the others all have cemented lintels. Eight steps to doors of six ornamental panels, with cornice head and radial fanlight, in panelled reveal with architrave. Doorcases of narrow engaged columns, entablature broken back and pediment to Nos 164 and 166. Others have fluted pilasters and moulded round architraves with keystones, one vermiculate, one with mask. Nos 170 and 170A only two windows wide; No 170A has projecting neo-Georgian shop front on ground floor. Included for group value and for doorcases. **172 and 174, Kennington Park Road** – locally listed.	1080388 -
75	**140–162, Kennington Park Road** Grade II listed. Long, near-symmetrical terrace of late 18th or early 19th century. Central three houses of four storeys and basement, outer ones of three storeys and basement, three windows. Stock brick with stone-coped parapet. Gauged flat brick arches to sash windows, some with glazing bars, many replaced. Two and five steps to doors of six fielded panels in banded rusticated reveal with reeded head and reeded and moulded architrave whose keystone rises to dentilled cornice and pediment, supported on console brackets. Patterned fanlights in central section and ornamental cast iron first floor window guards to long windows. Some door pediments are open.	1080387
76	**125–165, Kennington Park Road and attached railings and blind boxes** Grade II listed. Terrace of 21 houses. Late 18th century. Brown and yellow stock brick, some with stucco or red brick dressings; No.147 painted; Nos 131-3 & 149 painted at ground floor; No.129 stucco ground floor; most basements stuccoed. Slate or tiled roofs behind brick parapets, except No.125 which has stucco cornice and blocking course. All but Nos 135 & 137 with mansards with dormers. War damage has been repaired and some restoration and later alterations carried out. EXTERIOR: three storeys and basement, most with attics (except No.165 which is 4 storeys and basement), two bays each with two windows and door to ground floor; No.125 with two-storey, two-bay extension at left; Nos 131–137 with two-storey, one-bay entrance extensions, to left (Nos 131, 135), right (Nos 133, 137). Round-arched doors in round-arched recesses, Nos 125, 127, 131, 139–145, 151, 153 & 157 with decorative fanlights. No.125: doorcase with reeded, attached 3/4 Tuscan columns, reeded cornice head, original door; Nos 127 & 133: stucco Gibbs surround with vermiculated blocks to door with moulded cornice head, No.127 also with pilaster jambs; Nos 129 & 133 with wooden pilaster jambs to door with moulded cornice head; No.131 with double door under decorated segmental fanlight with narrow, reeded quadrant pilasters and cornice head and impost blocks with anthemion mouldings; Nos 135 & 137 with plain doorways with stucco imposts and doors with cornice heads, that to No.137 original; Nos 139, 141 & 151 with doors with moulded cornices in stucco surround with keystone; No.143: door in stucco surround with fluted pilaster jambs and cornice head; No.147 with stucco Gibbs surround to door with cornice head and imposts; Nos 149, 161 & 163: doors with moulded cornice heads, that to 163 with fluted pilaster jambs; Nos 153–159: doors with detached, reeded columns and moulded cornice heads; No.165: door with damaged stucco architrave, plain jambs and cornice head.	1385634
77	**136A, Kennington Park Road** Grade II listed. Half of an early 19th century pair, its partner destroyed. Three storeys, attic and basement, two windows, with two-storey and basement entrance bay. Stock brick with stuccoed basement and arcaded ground floor with impost band. Stone-coped parapet, slated mansard with dormers. Gauged flat brick arches to sash windows with glazing bars; patterned cast iron guards on ground floor. Eight steps with cast iron handrail to six-panel door, with reeded head and fanlight, in alternating block surround with vermiculate rustication and triple keystone.	1080385
78	**The White Bear Public House** Grade II listed. Mid 19th century, possibly with older core. Three storeys, five windows. Stucco with incised lines, entablature, and parapet. Moulded architraves, eared and triple keyed on first floor, to sash windows. Ground floor, refaced in cream architectural faience, has alternating doors and long plain windows. Original fascia and cornice remain. Included for group value.	1080386

HEA No.	Description	Site code/ GLHER/ NHLE No.
79	**114–124, Kennington Park Road** Grade II listed. Symmetrical early 19th century terrace, arranged as three pairs of three-storey and basement, two-window houses with narrower two-storey and basement entrance links, corresponding outer extensions (No 114 has extra storey added to outer bay). Stock brick with stuccoed cornice and blocking course and impost band to arcaded ground floor, also stuccoed arcade cills. Gauged flat brick arches to sash windows with glazing bars. Seven steps, with case iron handrails, to 6-panel doors with reeded head and patterned fanlight in alternating block surround with vermiculate rustications and triple keystone. No 114 has patterned cast iron ground floor window guards. All but No 118 have area railings or grids. Nos 122 and 124 have low-pitched front gable with split lunette attic windows. The others have slated mansards with dormers.	1080384
80	**21–25 Cleaver Square** Grade II listed. Mid 19th century by William Rogers. Each three storeys, one window, sunk basements. Stock brick with stuccoed quoins to projecting end houses, pilasters elsewhere, entablature with modillion and dentil cornice and blocking course. No 25 has added left entrance bay. Stuccoed basement and ground floor with banded rustication. Vermiculate quoins to projecting houses. Sash windows with margin lights in moulded architraves (except Nos 21 and 25, with modified entablature surrounds). Console bracketed dentil cornices and bracketed cills on ground floor. Six-panel doors with rectangular fanlights well set back behind modified entablature surrounds.	1184579
81	**26–33 Cleaver Square** Grade II listed. Mid 19th century terrace by William Rogers. Each house three storeys and sunk basement, one window. Stock brick, stuccoed quoins to projecting outer houses, pilasters dividing the others; enriched entablature and blocking course. Banded rustication to stucco basement and ground floor; vermiculate quoins to outer houses. Sash windows with margin lights or vertical bars in moulded architraves (eared and with scrolled feet and pediments on first floor) except on ground floor where they have panelled pilasters and console bracketed cornices. Altered doors in similar surrounds.	1080480
82	**Unlisted brick wall to rear of 164, Kennington Park Road**	–
83	**126–132, Kennington Park Road** Grade II listed. Two early 19th century pairs, each three storeys, attic and basement, two windows, with two-storey and basement linking entrance bay. Nos 126 and 128 have gable end with split lunette, others have slated mansard with dormers. Stock brick, stone-coped parapet. Cornice and blocking course in links. No 132 has link raised to full height in unmatched brick. Arcaded ground floor with impost band. Incised stucco basement and outer arcade piers to Nos 130 and 132. Gauged flat brick arches to sash window with glazing bars (No 128 modern casements). Eight steps with cast iron handrails to six-panel doors with reeded head and fanlight (No 126 radial) in alternating block surrounds with vermiculate rustication and triple keystone. Included for group value in spite of alterations.	1358302
84	**The Bishop's House** Grade II listed. Bishop's house, now day nursery. 1895. By Norman Shaw. For the Bishop of Rochester. Red brick with stone dressings in Queen Anne style with high pitched, swept tiled roof with deep, coved eaves and segment-headed dormers. two storeys, attic and basement, six bays to street front. Eight-bay left return has entrance in three-bay centre section, with stone architrave, pulvinated frieze, cornice and segmental pediment. Main windows are long with timber mullions and transoms and flat, gauged-brick arches and keystones, those on ground floor with blind boxes and those to basement segmental-headed. 1st-floor sill band. To the rear, the former chapel has large lunette windows with leaded lights and keystones. INTERIOR: not inspected.	1385631
85	**Gate piers and walls to The Bishops House** Grade II listed. Gate piers and walls, *c* 1895. Probably designed by the architect of the Bishop's House, Richard Norman Shaw. Brick in English bond with artificial stone dressings. Pair of gate piers at west end of site, square in section on plinth of brick; moulded capstone to each terminates in acanthus ball finial. To the right a round-arched opening with keystone and voussoir of artificial stone. Wall divided into 12 bays by setback pilasters; continuous parapet. Two additional bays at the east end of the wall. Forms a group with the Bishop's House (qv).	1385632

HEA No.	Description	Site code/ GLHER/ NHLE No.
86	**10, Kennington Park Place** Grade II listed. House and coach house, later office and flats. North western part built between 1805 and 1810, south eastern part was added probably *c* 1820 with attached former coach house also of *c* 1820. Stuccoed building with slate roof, mansard to south eastern part. EXTERIOR: North western part of three storeys and semi-basement; two windows. Parapet, bands between floors and end pilasters with incised Greek key design. Second floor has eight-pane sashes with panes laid horizontally in moulded architraves. First floor has tripartite sashes of 20 panes with cornice and bracket. Ground floor has taller 25-pane tripartite sashes and cast iron balconette with trellis pattern. Semi-basement has left side 16-pane sash and one blank. Rear elevation has parapet and 12-pane sashes. South eastern part is set back, of three storeys of lower height with matching parapet and pilaster with Greek key design. One original window but narrow later 19th century window to left hand side. Second floor round-headed blank and narrow later 19th century sash without glazing bars. First floor has tripartite sash of 16 panes and narrow later 19th century sash without glazing bars to left side. Ground floor has grand entrance underwooden canopy with wooden Doric half-columns. Doorcase with semi-circular fanlight, pilasters and original door with six octagonal panels, the two upper panels glazed. Two curved flights of stone steps have blank niches and central elaborate cast iron balustrading on base with blank round-headed arch with impost blocks and wreaths. Rear elevation has full-height curved bow of three bays with parapet, panels above top floor windows and sash windows. Attached former coach house to south east is of two storeys with deep cornice, pilasters, 16-pane sash to first floor and double doors and pedestrian entrance to ground floor. INTERIOR: Not inspected. HISTORY: The street was originally called St Agnes Place and houses were built between 1805 and 1810. The North western part is shown on Horwood's map of 1814. The whole building including the former coach house is shown on a print in "The Illustrated London News" of 1857 showing the Hustings at Kennington.	1379427
87	**11 and 12, Kennington Park Place** Grade II listed. Pair of semi-detached houses. Early-mid 19th century. Stock brick with brick parapet with inscribed pediment. Three storeys and basement, three-bay wide composition (central windows blind) with lower, set back entrance extensions to sides. Right-hand door with dentil cornice head, fanlight and panelled frieze has fluted pilaster jambs and impost bands. Windows to ground floor round-headed with stucco band at spring; others square-headed with flat, gauged-brick arches. All windows sashes with glazing bars. INTERIOR: not inspected.	1385630
88	**1–7 and attached railings, St Agnes Place** Grade II listed. Terrace of four houses. 1805–1808 (Nos.5 & 7 have later alterations). Multicoloured stock brick and stuccoed basement; slate mansard with dormers behind parapet. Three storeys, attic and basement, three bays each (No.7 has had an extra bay added). Ground-floor openings round-arched with stucco string at spring. Steps up to doors flanked by timber fluted Tuscan columns, and with reeded jambs, fanlight and cornice head continuous with string. Ground-floor sash windows in round-arched recesses resting on basement plinth. Flat, gauged-brick arches to upper-floor sash windows, those at 1st floor longer with iron grilles and stucco band. Bow windows to rear. INTERIOR: not inspected. SUBSIDIARY FEATURES: area railings and wrought-iron handrails to steps.	1385854
89	**Lodge at entrance to Kennington Park** Grade II listed. 1851 with alterations of 1898. Designed by H Roberts for Prince Albert to display working class housing at the 1851 Exhibition. Two storeys, three bays to road, central bay holding staircase. Stock brick with red brick bands and dressing including gauged brick window arches on ground floor. Stone lintels above. To minimise fire risk no wood is used in main structure. Brick vaulted ceilings, hollow tile internal walls, slate stairs and paved and concrete floors.	1185790
90	**Locally listed war memorial in northern end of Kennington Park**	–
91	**Unlisted 20th-century lodge in north-eastern corner of Kennington Park**	–
92	**20, Hanover Gardens** Grade II listed. Mid 19th century. Three storeys and basement, two windows. Stock brick with parapet. Second floor probably an addition. Gauged brick window arches, segmental on ground floor and basement. Windows missing. Ground floor band. Five steps to four-panel door set back behind entablature surround. Included for group value.	1299737

HEA No.	Description	Site code/ GLHER/ NHLE No.
93	**21–27, Hanover Gardens** Grade II listed. Mid 19th century. Each two storeys, attic and basement, two windows. Stock brick, painted basements to ground floor band. Stuccoed first floor cill band, frieze, cornice and blocking course. Slated mansard with dormers. Sash windows mostly with margin lights (some replaced with glazing bars) under gauged brick arches, segmental on ground floor. Four steps, with wrought iron handrail, to door of two long panels in stuccoed entablature surround. Cast iron spearhead area railings. No 26 set back.	1080442
94	**28–37, Hanover Gardens** Grade II listed. Mid 19th century terrace, the four central houses projecting slightly and the outer three at either side stepped back. Each three storeys and basement, two windows. Stock brick with painted basement. Stucco bands, frieze and cornice at second floor cills and top frieze, cornice and blocking course. Sash windows, mostly with margin lights, under gauged brick arches, segmental on ground floor. Five steps, with wrought iron handrails, to doors of two or four panels in stuccoed entablature surrounds. Cast iron spearhead area railings.	1080443
95	**38, Hanover Gardens** Grade II listed. Mid 19th century. Three storeys and basement, two windows. Stock brick with plain parapet. First floor band. Sash windows, mostly with margin lights, under gauged brick arches, segmental on ground floor. Five steps to door in stuccoed entablature surround.	1185313
96	**39 and 40, Hanover Gardens** Grade II listed. Mid 19th century. Each two storeys, attic and basement, two windows. Stock brick, painted basements to ground floor band. Stuccoed first floor cill band, frieze, cornice and blocking course. Slated mansard with dormers. Sash windows mostly with margin lights (some replaced with glazing bars) under gauged brick arches, segmental on ground floor. Four steps, with wrought iron handrail, to door of two long panels in stuccoed entablature surround. Cast iron spearhead area railings.	1358249
97	**41, 42 and 43, Hanover Gardens** Grade II listed. Mid 19th century. Each three storeys and basement, two windows. Stock brick with painted basement. Stucco bands, frieze and cornice at second floor cills and top frieze cornice and blocking course. Sash windows, mostly with margin lights, under gauged brick arches, segmental on ground floor. Five steps, with wrought iron handrails, to doors of two or four panels in stuccoed entablature surrounds. Cast iron spearhead area railings.	1080444
98	**44–48, Hanover Gardens** Grade II listed. Mid 19th century. Each two storeys, attic and basement, two windows. Stock brick, painted basements to ground floor band. Stuccoed first floor cill band, frieze, cornice and blocking course. Slated mansard with dormers. Sash windows mostly with margin lights (some replaced with glazing bars) under gauged brick arches, segmental on ground floor. Four steps, with wrought iron handrail, to door of two long panels in stuccoed entablature surround. Cast iron spearhead area railings. No 48 is three windows wide and has lost its cornice.	1185316
99	**49–54, Hanover Gardens** Grade II listed. Mid 19th century terrace with convex curved end. Each two storeys, attic and basement, two windows (except No 49 three windows), stock brick. Stucco bands at ground and first floor cills; frieze, cornice and blocking course (missing from Nos 49–52). Nos 49 and 50 have mansards; all have dormers, mostly altered. Sash windows, mostly with margin lights, under gauged brick arches, segmental on ground floor. Four steps, with wrought iron handrail, to doors of two long panels in stuccoed entablature surround. Cast iron spearhead area railings. Included for group value.	1358250
100	**2–7, Hanover Gardens** Grade II listed. Early-mid 19th century terrace, each three storeys and basement, two windows. Stock brick. Stuccoed ground floor with dentil cornices on console brackets over panelled pilasters and with shell antefixae. Stuccoed top frieze, cornice and blocking course. No 2 has altered ground floor. Sash windows with glazing bars in moulded architraves, with cornices over on first floor. Four-panel doors with cornice head and rectangular fanlight with margin lights. No 7 is curved round at right angle. Cast iron area railings. Included for group value.	1358248

HEA No.	Description	Site code/ GLHER/ NHLE No.
101	**The Hanover Arms Public House** Grade II listed. Includes No 1 Hanover Gardens. Early-mid 19th century. Three storeys. One bay on main front and a two-window rounded angle to Hanover Gardens front of four bays (of which two are No 1 Hanover Gardens). Stock brick, stucco frieze, cornice and parapet. Sash windows, some with glazing bars, in moulded architraves; cornices over on first floor. Early 20th century public house ground floor. Included for group value.	1299491
102	**Church of St Mark** Grade II* listed. 1822–24 built by D R Roper to the design of A B Clayton. Greek revival church of sandstone with Portland stone tetrastyle Doric porch in antis, up eight steps. Above the pediment a square tower bearing octagonal drum and open round Ionic stage with cupola; the whole decorated with acroteria. Single entrance, under small window, to narthex. Church splays out beyond to hold aisles. Five-bay returns with segment-headed windows on each floor. Pilaster bay divisions support entablature. Side entrances to narthex; and crypt entrances further east. Projecting centre at east with large window. Inside shows gallery on Doric columns round three sides. Aisles and galleries walled off in reconstruction after war damage; but screen of two tall piers of Ionic columns before east window remains. Central glass dome. 17th century pulpit from St Michael, Wood Street.	1080383
103	**Wall and piers around west, north and east sides of St Mark's Church** Grade II listed. Low, dark granite walls; at intervals, tall pale granite piers with Portland stone round pedimented caps.	1358301
104	**The Whittington Lodge** By Sir Clough-Williams Ellis (1906), the sole-surviving pre-war building on the Battersea Dogs and Cats Home site.	–
105	**106, 108–110 (land adjacent) Alberta Street, Kennington, SE17** CA evaluation in 2001. Overlying the natural silt was a soil horizon, presumably the land surface prior to development in the 1790s. This was sealed by several layers of made-ground, which relates to the development of the site as domestic gardens in the 19th and early 20th century.	ABA01
106	**Kennington Underground Station** Grade II listed. 1890–1925. Exterior by T P Figgis for the City and South London Railway. Red brick with white stone dressings; brick parapet and, to rear, large lead dome resting on roughcast drum and surmounted by small cupola. Classical 1-storey building with 2-bay front, canted corner, and 6 bay return to Braganza Street. Stone pilasters resting on plinth and supporting entablature define bays. Bay to left front is wider and has shop window under elliptical arch. To right, a doorway with moulded stone architrave, frieze and cornice. Main entrance on canted corner with new canopy and tiled parapet. Set-back entrance bay to right end of return elevation has round-arched doorway (now blocked up) with brick voussoirs, keystone and entablature on consoles. Altered booking hall with roof lantern and plain tiling. Dome housed the workings of a hydraulic lift. Of historical interest as one of the first stations on the original City and South London Railway and the only one of those to retain much of its original character.	1385635
107	**1 and 5 Montford Place** Locally listed, classically-styled brick buildings of the early 20th century.	–

10 Planning framework

10.1 Statutory protection

Planning (Listed Buildings and Conservation Areas) Act 1990

10.1.1 The Act sets out the legal requirements for the control of development and alterations which affect buildings, including those which are listed or in conservation areas. Buildings which are listed or which lie within a conservation area are protected by law. Grade I are buildings of exceptional interest. Grade II* are particularly significant buildings of more than special interest. Grade II are buildings of special interest, which warrant every effort being made to preserve them.

10.2 Register of Parks and Gardens of Special Historic Interest

10.2.1 Kennington Park, located within the study area, is a Grade II Registered Park and Garden of Special Historic Interest. Although inclusion of an historic park or garden on the Register in itself brings no additional statutory controls, local authorities are required by central government to make provision for the protection of the historic environment in their policies and their allocation of resources. Registration is a material consideration in planning terms so, following an application for development which would affect a registered park or garden, local planning authorities must, when determining whether or not to grant permission, take into account the historic interest of the site.

10.2.2 To ensure that local planning authorities have the appropriate professional advice when considering such applications, they are required to consult the Garden History Society on all applications affecting registered sites, regardless of the grade of the site (see Central Government Circular 9/95, and summary in Environment Circular 14/97 /Culture, Media and Sport Circular 1/97).

10.3 National Planning Policy Framework

10.3.1 The Government issued the National Planning Policy Framework (NPPF) in March 2012 (DCLG 2012). One of the 12 core principles that underpin both plan-making and decision-taking within the framework is to 'conserve heritage assets in a manner appropriate to their significance, so that they can be enjoyed for their contribution to the quality of life of this and future generations' (DCLG 2012 para 17). It recognises that heritage assets are an irreplaceable resource (para 126), and requires the significance of heritage assets to be considered in the planning process, whether designated or not. The contribution of setting to asset significance needs to taken into account (para 128). The NPPF encourages early engagement (i.e. pre-application) as this has significant potential to improve the efficiency and effectiveness of a planning application and can lead to better outcomes for the local community (para 188).

10.3.2 Although the NPPF has superseded PPS5, the PPS5 guidance is still in place (DCLG, EH & DCMS, March 2010).

10.3.3 NPPF Section 12: Conserving and enhancing the historic environment, is produced in full below:

> **Para 126**. Local planning authorities should set out in their Local Plan a positive strategy for the conservation and enjoyment of the historic environment, including heritage assets most at risk through neglect, decay or other threats. In doing so, they should recognise that heritage assets are an irreplaceable resource and conserve them in a manner appropriate to their significance. In developing this strategy, local planning authorities should take into account:
>
> - the desirability of sustaining and enhancing the significance of heritage assets and putting them to viable uses consistent with their conservation;

- the wider social, cultural, economic and environmental benefits that conservation of the historic environment can bring;
- the desirability of new development making a positive contribution to local character and distinctiveness; and
- opportunities to draw on the contribution made by the historic environment to the character of a place.

Para 127. When considering the designation of conservation areas, local planning authorities should ensure that an area justifies such status because of its special architectural or historic interest, and that the concept of conservation is not devalued through the designation of areas that lack special interest.

Para 128. In determining applications, local planning authorities should require an applicant to describe the significance of any heritage assets affected, including any contribution made by their setting. The level of detail should be proportionate to the assets' importance and no more than is sufficient to understand the potential impact of the proposal on their significance. As a minimum the relevant historic environment record should have been consulted and the heritage assets assessed using appropriate expertise where necessary. Where a site on which development is proposed includes or has the potential to include heritage assets with archaeological interest, local planning authorities should require developers to submit an appropriate desk-based assessment and, where necessary, a field evaluation.

Para 129. Local planning authorities should identify and assess the particular significance of any heritage asset that may be affected by a proposal (including by development affecting the setting of a heritage asset) taking account of the available evidence and any necessary expertise. They should take this assessment into account when considering the impact of a proposal on a heritage asset, to avoid or minimise conflict between the heritage asset's conservation and any aspect of the proposal.

Para 130. Where there is evidence of deliberate neglect of or damage to a heritage asset the deteriorated state of the heritage asset should not be taken into account in any decision.

Para 131. In determining planning applications, local planning authorities should take account of:

- the desirability of sustaining and enhancing the significance of heritage assets and putting them to viable uses consistent with their conservation;
- the positive contribution that conservation of heritage assets can make to sustainable communities including their economic vitality; and
- the desirability of new development making a positive contribution to local character and distinctiveness.

Para 132: When considering the impact of a proposed development on the significance of a designated heritage asset, great weight should be given to the asset's conservation. The more important the asset, the greater the weight should be. Significance can be harmed or lost through alteration or destruction of the heritage asset or development within its setting. As heritage assets are irreplaceable, any harm or loss should require clear and convincing justification. Substantial harm to or loss of a grade II listed building, park or garden should be exceptional. Substantial harm to or loss of designated heritage assets of the highest significance, notably scheduled monuments, protected wreck sites, battlefields, grade I and II* listed buildings, grade I and II* registered parks and gardens, and World Heritage Sites, should be wholly exceptional.

Para 133. Where a proposed development will lead to substantial harm to or total loss of significance of a designated heritage asset, local planning authorities should refuse consent, unless it can be demonstrated that the substantial harm or loss is necessary to achieve substantial public benefits that outweigh that harm or loss, or all of the following apply:

- the nature of the heritage asset prevents all reasonable uses of the site; and

- no viable use of the heritage asset itself can be found in the medium term through appropriate marketing that will enable its conservation; and
- conservation by grant-funding or some form of charitable or public ownership is demonstrably not possible; and
- the harm or loss is outweighed by the benefit of bringing the site back into use.

Para 134. Where a development proposal will lead to less than substantial harm to the significance of a designated heritage asset, this harm should be weighed against the public benefits of the proposal, including securing its optimum viable use.

Para 135. The effect of an application on the significance of a non-designated heritage asset should be taken into account in determining the application. In weighing applications that affect directly or indirectly non designated heritage assets, a balanced judgement will be required having regard to the scale of any harm or loss and the significance of the heritage asset.

Para 136. Local planning authorities should not permit loss of the whole or part of a heritage asset without taking all reasonable steps to ensure the new development will proceed after the loss has occurred.

Para 137. Local planning authorities should look for opportunities for new development within Conservation Areas and World Heritage Sites and within the setting of heritage assets to enhance or better reveal their significance. Proposals that preserve those elements of the setting that make a positive contribution to or better reveal the significance of the asset should be treated favourably.

Para 138. Not all elements of a World Heritage Site or Conservation Area will necessarily contribute to its significance. Loss of a building (or other element) which makes a positive contribution to the significance of the Conservation Area or World Heritage Site should be treated either as substantial harm under paragraph 133 or less than substantial harm under paragraph 134, as appropriate, taking into account the relative significance of the element affected and its contribution to the significance of the Conservation Area or World Heritage Site as a whole.

Para 139. Non-designated heritage assets of archaeological interest that are demonstrably of equivalent significance to scheduled monuments, should be considered subject to the policies for designated heritage assets.

Para 140. Local planning authorities should assess whether the benefits of a proposal for enabling development, which would otherwise conflict with planning policies but which would secure the future conservation of a heritage asset, outweigh the disbenefits of departing from those policies.

Para 141. Local planning authorities should make information about the significance of the historic environment gathered as part of plan-making or development management publicly accessible. They should also require developers to record and advance understanding of the significance of any heritage assets to be lost (wholly or in part) in a manner proportionate to their importance and the impact, and to make this evidence (and any archive generated) publicly accessible. However, the ability to record evidence of our past should not be a factor in deciding whether such loss should be permitted.

10.3.4 Conserving cultural heritage within National Parks, the Broads, and Areas of Outstanding Natural Beauty is an important consideration (para 115), along with preserving the setting and special character of historic towns, with particular reference to Green Belt land (para 80). NPPF states that planning permission should be refused for 'development resulting in the loss or deterioration or irreplaceable habitats, including ancient woodland and the loss of aged or veteran trees found outside ancient woodland, unless the need for, and benefits of, the development in that location clearly outweigh the loss' (para 118). Adverse impacts on the historic environment are also a consideration in mineral extraction (paras 143; 144).

10.4 Greater London regional policy

The London Plan

10.4.1 The overarching strategies and policies for the whole of the Greater London area are contained within the London Plan of the Greater London Authority (GLA July 2011). Policy 7.8 relates to Heritage Assets and Archaeology:

> **Strategic**
>
> A. London's heritage assets and historic environment, including listed buildings, registered historic parks and gardens and other natural and historic landscapes, conservation areas, World Heritage Sites, registered battlefields, scheduled monuments, archaeological remains and memorials should be identified, so that the desirability of sustaining and enhancing their significance and of utilising their positive role in place shaping can be taken into account.
>
> B. Development should incorporate measures that identify, record, interpret, protect and, where appropriate, present the site's archaeology.
>
> **Planning decisions**
>
> C. Development should identify, value, conserve, restore, re-use and incorporate heritage assets, where appropriate.
>
> D. Development affecting heritage assets and their settings should conserve their significance, by being sympathetic to their form, scale, materials and architectural detail.
>
> E. New development should make provision for the protection of archaeological resources, landscapes and significant memorials. The physical assets should, where possible, be made available to the public on-site. Where the archaeological asset or memorial cannot be preserved or managed on-site, provision must be made for the investigation, understanding, recording, dissemination and archiving of that asset.
>
> **LDF preparation**
>
> F. Boroughs should, in LDF policies, seek to maintain and enhance the contribution of built, landscaped and buried heritage to London's environmental quality, cultural identity and economy as part of managing London's ability to accommodate change and regeneration.
>
> G. Boroughs, in consultation with English Heritage, Natural England and other relevant statutory organisations, should include appropriate policies in their LDFs for identifying, protecting, enhancing and improving access to the historic environment and heritage assets and their settings where appropriate, and to archaeological assets, memorials and historic and natural landscape character within their area.

10.5 Local planning policies

10.5.1 Following the Planning and Compulsory Purchase Act 2004, LPAs are replacing their Unitary Development Plans (UDPs), Local Plans and Supplementary Planning Guidance with a new system of Local Development Frameworks (LDFs). In the meantime, UDP policies are either 'saved' or 'deleted'.

10.5.2 Policies adopted prior to the NPPF in March 2012 may make reference to the previous Planning Policy Statement 5 (PPS5) or Planning Policy Guidance (PPG) 15 and 16, which concerned the historic environment. The NPPF has superseded these, but its provisions and guidance are broadly in line with them.

Lambeth

10.5.3 The development plan in Lambeth is the London Plan (July 2011), the Lambeth Core Strategy (adopted 19th January 2011) and the remaining saved, non-superseded policies of the UDP, currently referred to as the *Unitary Development Plan 2007: Policies saved beyond 5 August 2010 and not superseded by the Core Strategy 2011*. These policies are the basis on which all applications for planning

permission will be decided, and material considerations include national planning policy statements and planning policy guidance (London Borough of Lambeth website, accessed 2nd January 2013).

10.5.4 The Core Strategy's strategic objective 15 is to

> Create and sustain distinctive local places through excellent design of buildings and the public realm, valuing heritage, identity, cultural assets and the natural environment.

10.5.5 Strategic objective 16 is to:

> Protect and enhance the historic built environment, the setting of the Palace of Westminster World Heritage sites and strategic views by working in partnership with English Heritage, neighbouring boroughs and community groups.

10.5.6 Concerning built heritage, the Core Strategy states that:

> **2.37** Lambeth has approximately 2,500 listed buildings. The vast majority of these are nineteenth century residential dwellings reflecting the historical development of the borough. Typically two or three structures are added to the statutory list each year. A local list of historically significant buildings (not on the national list) is being prepared.
>
> **2.38** There are 62 conservation areas in Lambeth covering approximately 30 per cent of the borough. The first was designated in 1969 and the most recent in 2009. These are also mostly residential in character, with the notable exceptions of the South Bank, characterised by post-war cultural and civic buildings, and West Norwood with its nineteenth century cemetery and many fine monuments. The borough also has seventeen Archaeological Priority Zones and eight historic Registered Parks and Gardens (of which two are private), and has protected strategic views in the north of the borough of St Paul's Cathedral and the Palace of Westminster (a World Heritage site).

10.5.7 The Core Strategy makes reference to

> National planning policy sets out the requirements for the protection and enhancement of listed buildings, archaeological heritage and the character and appearance of conservation areas.

10.5.8 Policy S9 – Quality of the Built Environment – states

> The Council will improve and maintain the quality of the built environment and its liveability, in order to sustain stable communities, by:
>
> (a) Seeking the highest quality of design in all new buildings, alterations and extensions and the public realm. Innovation in design will be supported and encouraged, particularly where this contributes to local distinctiveness, enhances the existing built environment and heritage, reflects the cultural diversity of the borough and creates new high quality areas of public realm.
>
> (b) Safeguarding and promoting improvements to the borough's heritage assets including appropriate uses and improvements to listed buildings, maintaining a local list of heritage assets, carrying out conservation area character appraisals and management plans, and making appropriate provision for assets of archaeological value.
>
> (c) Protecting strategic views, including those that affect the outstanding universal value and setting of the Westminster World Heritage Site.
>
> (d) Supporting tall buildings where they are an appropriate development form for the area, particularly where this contributes to area regeneration and local distinctiveness, makes the most effective use of land and is consistent with national and London Plan policies and guidance. Appropriate locations for tall buildings are parts of the Vauxhall and Waterloo London Plan Opportunity Areas and Brixton town centre, subject to appropriate accompanying urban design
>
> assessments. The height of buildings should be appropriate to the surrounding townscape.
>
> (e) Improving the quality of the public realm to ensure that it supports regeneration objectives, is child-friendly, incorporates ecological features making the most of opportunities to promote biodiversity, encourages physical activity, is accessible for

people with disabilities, supports sustainable travel and includes safe and attractive pedestrian and cycle routes within and through neighbourhoods, linked to green

spaces and public transport nodes and interchanges.

(f) Creating safe and secure environments that reduce the scope for crime, fear of crime, anti-social behaviour and fire, having regard to Secured by Design standards, and addressing resilience to terrorism in major development proposals.

(g) Managing the public realm in partnership with businesses and users.

10.5.9 Core Strategy Policy S5 – Open Space includes a commitment to

Improving the quality of, and access to, existing open space, including the range of facilities available and its bio-diversity and nature conservation value and heritage value, through various means including the implementation of the Lambeth Open Spaces Strategy. Where appropriate in major developments, financial contributions will be sought towards improvements in the quality of, and access to, open space in the borough.

10.5.10 UDP policies relating to built heritage have been saved:

Policy 45 Listed Buildings

(a) Preservation - The Council will preserve listed buildings for their special architectural or historic interest. Consent for the demolition of a listed building will only be granted in exceptional circumstances.

(b) Alterations and Extensions - Consent for alterations and extensions may be granted where the result preserves the special interest of the building. Where repairs, alterations (including shop fronts) or extensions are necessary, they must relate sensitively to the original building and will require craftsmanship and professional skill of a high standard. There will be a presumption in favour of the use of original materials and traditional repair and construction methods. All aspects of proposals should be necessary and should protect the architectural or historic integrity and detailing of the exterior of the buildings and valuable interiors, and should be fully in accord with the period, style and detailing of the building. Where the existing original roof structure is of specific architectural or historic interest, it should be preserved. Extensions that adversely affect the internal appearance of listed buildings will not be acceptable.

(c) Repair and Retention - To protect historic quality, retention and repair of features, rather than replacement, will be expected. The applicant will need to demonstrate that alterations, extensions and other structural works to listed buildings can be carried out without putting the retained historic fabric at risk.

(d) Original Features - Features of architectural or historic interest should be retained, including internal and external decorative features such as: fireplaces, windows (including shop fronts), external and internal doors, panelling, window boxes and shutters, staircase balustrades and other decorative woodwork, decorative ironwork, tiles, plaster, stucco work and other features of importance. Where such features are beyond repair or missing, they should be replaced with historically accurate replicas using traditional materials and craft techniques. Redundant historic materials should be retained for re-use wherever possible.

(e) Plan Form - The original plan forms and internal and external spatial quality of historic buildings should be preserved and not compromised by unsympathetic alterations or extensions. Proposals for lateral conversion between historic buildings where this would compromise their original plan forms or adversely affect the internal appearance of important rooms or spaces will be refused. In general, it will not be acceptable to make breaches in the party wall between historic buildings on the ground and first floors or in other sensitive locations, or to demolish and redevelop behind a retained façade. This is particularly important for 17th, 18th and 19th Century buildings of cellular form.

(f) Setting - Development which adversely affects the setting of a listed building, or significant views of a listed building, will be refused.

(g) Changes of use - Wherever possible, the original use of an historic building should be retained, particularly if it is residential. If the use has been changed from the original, reversion to the original may be desirable. In some cases, the survival of the building may entail finding an alternative appropriate new use - this should

minimise damage to historic or important features and statutory requirements, such as fire escapes and services, will need to be integrated sensitively.

(h) Listed Building Planning Applications - Listed Building Applications

involving alterations to listed buildings should include photographs and a

schedule of building works. Planning applications affecting listed buildings

should be fully detailed and not in outline form.

(i) Listed Buildings at Risk - The Council will work with owners of Listed Buildings and English Heritage to bring into sustainable use and good repair and thus preserve Buildings-at-Risk in the Borough.

Policy 46 List of Buildings of Local Architectural Interest

The Council will compile and adopt a list of buildings and structures of local historic or architectural interest. The Council will use development control procedures to resist proposals for the demolition or inappropriate alteration of buildings or structures on the local list. This may, in appropriate cases, result in the urgent inclusion of a building in a Conservation Area, or imposing reasonable restrictions on the redevelopment of the site. Proposals for the alteration or extension of buildings on the local list will be expected to relate sensitively to the building or structure, and respect its architectural or historic interest. The Council will seek to preserve features of such buildings which contribute to that interest.

Policy 47 Conservation Areas

(a) Protection - Development proposals in a conservation area should preserve or enhance the character or appearance of the conservation area.

(b) Design Guides - Lambeth will designate new conservation areas where the character of the area justifies this. The Council will prepare and adopt character appraisals for its conservation areas.

(c) Demolition - The Council will resist granting consent for the demolition of a building, or a substantial part of a building that makes a positive contribution to a character or appearance of a conservation area. The demolition behind a retained façade is generally destructive to the character of a building and should be avoided, particularly for traditional buildings of cellular form such as houses. Where demolition in a conservation area is acceptable, for example because the building does not contribute to the area, and its redevelopment would be beneficial in townscape term then a full planning application will be required to accompany the application for conservation area consent. Such replacement buildings should follow policy 33 and the opportunity should be seen as a stimulus to imaginative, high-quality design. Consent for demolition will be subject to a condition and/or section 106 agreement that the building shall not be demolished until a contract for new work has been made and planning permission for those works has been granted.

(d) Alterations and Extensions - Alterations to elevations of buildings in conservation areas, including window designs and shop fronts should preserve or enhance features of the original building, having regard to policy 36. Characteristic features such as doors, canopies, windows, porticos, porches, roof details (e.g. chimneys, chimney pots, roofline and pitch) and party wall upstands should be retained and not unacceptably altered, even when these elements may be redundant. Extensions to buildings in conservation areas should not alter the scale or roofline of the building detrimental to the unity or character of the conservation area and should be complementary to the original building in elevational features. Where minor alterations and development, individually and cumulatively, are leading to an erosion of the character and appearance of a conservation area, then public consultation powers (under article 3 (1) and 4 (2) of the GDPO 1990) will be used to bring such changes under planning control.

(e) Boundaries - Development should preserve and reinstate characterful traditional uniform boundary treatment of the area, for example re-instating front boundary cast iron railings, or brick garden walls.

(f) Open Areas - In conservation areas, the loss of the following, or views of the following, where possible will be resisted where they form an integral part of the character or appearance of the area – landscaped areas, private and public

gardens, original and characterful garden boundaries, trees of amenity value and hedges.

(g) Setting and Views - Development outside conservation areas should not harm the setting of the area or harm views into or from the area.

(h) Outline Applications - Applications in conservation areas should contain sufficient detail to enable assessment within the townscape context. Outline applications will generally not be acceptable, other than in those limited circumstances of regeneration areas. (E.g. South Bank Centre and Town Centres), where a masterplan or development framework of sufficient detail is approved. The outline consent can help guarantee the delivery of the objectives of the masterplan or development framework and the protection of the special character or appearance of the Conservation Area.

(i) Changes of Use - As Policy 45 (g)

(j) Enhancement - The enhancement of conservation areas and the improvement and restoration of properties within conservation areas is encouraged and will be promoted in conjunction with local residents and societies.

Southwark

10.5.11 The Southwark UDP was adopted in July 2007 (Southwark Council, 2007). The Southwark Core Strategy 2011 was adopted in April 2011(Southwark Council, 2011). Strategic Policy 12 (Design and conservation) states that development should

> conserve or enhance the significance of Southwark's heritage assets, their settings and wider historic environment, including conservation areas, archaeological priority zones and sites, listed and locally listed buildings, registered parks and gardens, world heritage sites and scheduled monuments (Southwark Council, 2011).

10.5.12 The saved policies of the Southwark UDP are now part of the LDF. These include policies relevant to the historic environment which are set out below:

Policy 3.15 Conservation of the Historic Environment

Development should preserve or enhance the special interest or historic character or appearance of buildings or areas of historical or architectural significance. Planning proposals that have an adverse effect on the historic environment will not be permitted. The character and appearance of Conservation Areas should be recognised and respected in any new development within these areas. Article 4 directions may be imposed to limit permitted development rights, particularly in residential areas. In this policy the term historic environment includes Conservation Areas, listed buildings, scheduled monuments, protected London Squares, historic parks and gardens and trees that are protected by Tree Preservation Orders, trees that contribute to the character or appearance of a Conservation Area and ancient hedgerows.

Policy 3.16 Conservation Areas

Within Conservation Areas, development should preserve or enhance the character or appearance of the area. New Development, including Alterations and Extensions Planning permission will be granted for new development, including the extension or alteration of existing buildings provided that the proposals:

i. Respect the context of the Conservation Area, having regard to the content of Conservation Area Appraisals and other adopted Supplementary Planning Guidance / Documents; and

ii. ii. Use high quality materials that complement and enhance the Conservation Area; and

iii. iii. Do not involve the loss of existing traditional features of interest which make a positive contribution to the character or appearance of the Conservation Area; and

iv. iv. Do not introduce design details or features that are out of character with the area, such as the use of windows and doors made of aluminium, uPVC or other non-traditional materials;

Where appropriate development in Conservation Areas may include the use of modern materials or innovative techniques only where it can be demonstrated in a design and access statement that this will preserve or enhance the character or appearance of the Conservation Area.

Demolition

Within Conservation Areas, there will be a general presumption in favour of retaining buildings that contribute positively to the character or appearance of the Conservation Area. Planning permission will not be granted for proposals that involve the demolition or substantial demolition of a building that contributes positively to the character or appearance of the Conservation Area, unless, in accordance with PPG15 or any subsequent amendments, it can be demonstrated that:

i. The costs of repairs and maintenance would not be justified, when assessed against the importance of the building and the value derived from its continued use, providing that the building has not been deliberately neglected; and

ii. Real efforts have been made to the continue the current use or find a viable alternative use for the building; and

iii. There will be substantial planning benefits for the community from redevelopment which would decisively outweigh loss from the resulting demolition; and

iv. The replacement development will preserve or enhance the character or appearance of the conservation area and has been granted planning permission.

Implementation

Submission of details demonstrating that a contract for the construction of the replacement development has been let will be required prior to implementation of the development.

Policy 3.17 Listed Buildings

Development proposals involving a listed building should preserve the building and its features of special architectural or historic interest.

Alterations and extensions

Planning permission for proposals which involve an alteration or extension to a listed building will

only be permitted where:

i. There is no loss of important historic fabric; and

ii. The development is not detrimental to the special architectural or historic interest of the building; and

iii. The development relates sensitively and respects the period, style, detailing and context of the listed building or later alterations of architectural or historic interest; and

iv. Existing detailing and important later additional features of the building are preserved,

repaired or, if missing, replaced.

Demolition

There will be a general presumption in favour of the retention of listed buildings. Planning permission will not be granted for proposals that involve the demolition or substantial demolition of a listed building, unless, in accordance with PPG15 or any subsequent amendments, it can be demonstrated that:

i. The costs of repairs and maintenance would not be justified, when assessed against the importance of the building and the value derived from its continued use, providing that the building has not been deliberately neglected; and

ii. Real efforts have been made to continue the current use or find a viable alternative use for the building; and

iii. There will be substantial planning benefits for the community from redevelopment which would decisively outweigh the loss from the resulting demolition.

Listed building consent must be applied for contemporaneously with an application for planning permission for a redevelopment scheme. Submission of details demonstrating that a contract for the construction of the replacement development has been let will be required prior to implementation of the development.

Policy 3.18 Setting of Listed Buildings, Conservation Areas and World Heritage Sites

Permission will not be granted for developments that would not preserve or enhance:

i. The immediate or wider setting of a listed building; or

ii. An important view(s) of a listed building; or

iii. The setting of the Conservation Area; or

iv. Views into or out of a Conservation Area; or

v. The setting of a World Heritage Site; or

vi. Important views of /or from a World Heritage Site.

Policy 3.19 Archaeology

Planning applications affecting sites within Archaeological Priority Zones (APZs), as identified in Appendix 8, shall be accompanied by an archaeological assessment and evaluation of the site, including the impact of the proposed development. There is a presumption in favour of preservation in situ, to protect and safeguard archaeological remains of national importance, including scheduled monuments and their settings. The in situ preservation of archaeological remains of local importance will also be sought, unless the importance of the development outweighs the local value of the remains. If planning permission is granted to develop any site where there are archaeological remains or there is good reason to believe that such remains exist, conditions will be attached to secure the excavation and recording or preservation in whole or in part, if justified, before development begins.

Wandsworth

10.5.13 The current Local Plan for the borough consists of: the Core Strategy, adopted October 2010; the Development Management Policies Document (DMPD), adopted February 2012; the Site Specific Allocations Document (SSAD), adopted February 2012; the Proposals Maps, adopted February 2012; and the Authority Monitoring Report (AMR). The London Plan, adopted July 2011 adopted July 2011, is also part of the development plan for the borough (London Borough of Wandsworth website, accessed 2nd January 2013).

10.5.14 The Core Strategy includes under its strategic Environmental Objectives:

> Protect, reinforce and repair the existing distinctive character of the different districts of the borough, placing full value on the heritage and amenity of each different district (Wandsworth Council 2010a, 18).

10.5.15 The DMPD sets out the Council's policies which include the protection and enhancement of the built heritage of the Borough (Wandsworth Council 2012, 16–17). Policy DMS2 provides protection to the historic environment

Policy DMS 2 Managing the historic environment

a. In addition to satisfying the relevant parts of Policy DMS1, applications affecting a heritage asset or its setting will be granted where it:

i. is in accordance with PPS 5, the London Plan and relevant English Heritage guidance;

ii. takes full account of the Council's Conservation Area Appraisals and Management Strategies;

iii. is accompanied by a satisfactory Heritage Statement produced by a heritage specialist where appropriate.

b. Applications will be granted where they sustain, conserve and, where appropriate, enhance the significance, appearance, character and setting of the heritage asset itself, and the surrounding historic environment, and where they have consideration for the following:

i. the conservation of features and elements that contribute to the heritage asset's significance and character. This may include: chimneys, windows and doors, boundary treatments, original roof coverings, shopfronts or elements of shopfronts in conservation areas, as well as internal features such as fireplaces, plaster cornices, doors, architraves, panelling and any walls in listed buildings;

ii. the reinstatement of features and elements that contribute to the heritage asset's significance which have been lost which may include any of the above items or others;

iii. the conservation and, where appropriate, the enhancement of the space in between and around buildings as well as front, side and rear gardens;

iv. the removal of additions or modifications that are considered harmful to the significance of any heritage asset. This may include the removal of pebbledash, paint from brickwork, non-original style windows, doors, satellite dishes or other equipment;

v. the use of the heritage asset should be compatible with the conservation of its significance;

vi. historical information discovered during the application process shall be submitted to the Greater London Historic Environment Record.

c. Development involving the demolition or removal of significant parts of heritage assets will be granted in exceptional circumstances which have been clearly and convincingly demonstrated to be in accordance with the requirements of PPS 5 policies HE 9 and 10.

d. Proposals for development involving ground disturbance in Archaeological Priority Areas (as identified on the proposals map), will need to be assessed and may be required to be accompanied by an archaeological evaluation report. The recording and publication of results will be required and in appropriate cases, the Council may also require preservation in situ, or excavation.

e. Further detail will be set out in a forthcoming Historic Environment Supplementary Planning Document (SPD).

11 Determining significance

11.1.1 'Significance' lies in the value of a heritage asset to this and future generations because of its heritage interest, which may be archaeological, architectural, artistic or historic. Archaeological interest includes an interest in carrying out an expert investigation at some point in the future into the evidence a heritage asset may hold of past human activity, and may apply to standing buildings or structures as well as buried remains.

11.1.2 Known and potential heritage assets within the study area have been identified from national and local designations, data from the Historic Environment Record and expert opinion. The determination of the significance of these assets is based on statutory designation and/or professional judgement against four values (EH 2008):

- *Evidential value*: the potential of the physical remains to yield evidence of past human activity. This might take into account date; rarity; state of preservation; diversity/complexity; contribution to published priorities; supporting documentation; collective value and comparative potential.
- *Aesthetic value*: this derives from the ways in which people draw sensory and intellectual stimulation from the heritage asset, taking into account what other people have said or written;
- *Historical value*: the ways in which past people, events and aspects of life can be connected through heritage asset to the present, such a connection often being illustrative or associative;
- *Communal value*: this derives from the meanings of a heritage asset for the people who know about it, or for whom it figures in their collective experience or memory; communal values are closely bound up with historical, particularly associative, and aesthetic values, along with and educational, social or economic values.

11.1.3 Table 3 gives examples of the significance of designated and non-designated heritage assets.

Table 3: Significance of heritage assets

Heritage asset description	Significance
World heritage sites Scheduled monuments Grade I and II* listed buildings English Heritage Grade I and II* registered parks and gardens Protected Wrecks Heritage assets of national importance	Very high (International / national)
English Heritage Grade II registered parks and gardens Conservation areas Designated historic battlefields Grade II listed buildings Burial grounds Protected heritage landscapes (e.g. ancient woodland or historic hedgerows) Heritage assets of regional or county importance	High (national/ regional/ county)
Heritage assets with a district value or interest for education or cultural appreciation Locally listed buildings	Medium (District)
Heritage assets with a local (i.e. parish) value or interest for education or cultural appreciation	Low (Local)
Historic environment resource with no significant value or interest	Negligible
Heritage assets that have a clear potential, but for which current knowledge is insufficient to allow significance to be determined	Uncertain

11.1.4 Unless the nature and exact extent of buried archaeological remains within any

given area has been determined through prior investigation, the significance of heritage assets which comprise below ground archaeological remains is often uncertain.

11.1.5 Built heritage and above ground archaeological remains (e.g. earthworks and landscapes) are visible and tangible and, where appropriate, significance is considered in more detail. 'Built heritage' refers to those aspects of the buildings visible on the site that possess noteworthy architectural or historic interest. These aspects of the buildings have been identified and their interest has been rated very broadly, using the published criteria for statutory listing of buildings for their special architectural or historic interest, in English Heritage 'conservation principles' (EH 2008) and applicable guidance published by English Heritage on selecting buildings for listing (or designation as heritage assets) (2007) and on investigating and recording buildings archaeologically (2006). Criteria for listing includes:

- 'architectural interest:… of importance to the nation for… their architectural design, decoration and craftsmanship; …important examples of particular building types and techniques… and significant plan forms;
- 'historic interest: … illustrate important aspects of the nation's social, economic, cultural or military history;
- 'close historical association with nationally important people or events;
- 'group value, especially where buildings comprise an important architectural or historic unity or a fine example of planning…'

11.1.6 Evidential and aesthetic values correspond most closely to architectural interest, in terms of the published criteria for listing, while historical and communal values correspond to historic interest. These values emphasise national importance as being necessary for statutory listing, but are also useful in considering the particular architectural or historic interest of any building or structure.

12 Non-archaeological constraints

12.1.1 It is anticipated that live services will be present on the site, the locations of which have not been identified by this archaeological report. Other than this, no other non-archaeological constraints to any archaeological fieldwork have been identified within the site.

12.1.2 Previous and current site uses indicate that there is a risk of contamination being present at the **Battersea station** site, due to its proximity to the former power station. The **Nine Elms station** site has been used as stables, timber yard and saw mills, stores, assorted works, a button factory, and a stonemasonry works. It was also bordered to the west by the railway lines associated with the Nine Elms Goods Depot and the main line into Waterloo station. Current land uses include the car park and petrol station at Sainsbury's, Banham (security system supplies) and a chimney which is believed to be associated with an incinerator.

12.1.3 Note: the purpose of this section is to highlight to decision makers any relevant non-archaeological constraints identified during the study, that might affect future archaeological field investigation on the site (should this be recommended). The information has been assembled using only those sources as identified in section 2 and section 14.4, in order to assist forward planning for the project designs, working schemes of investigation and risk assessments that would be needed prior to any such field work. MOLA has used its best endeavours to ensure that the sources used are appropriate for this task but has not independently verified any details. Under the Health & Safety at Work Act 1974 and subsequent regulations, all organisations are required to protect their employees as far as is reasonably practicable by addressing health and safety risks. The contents of this section are intended only to support organisations operating on this site in fulfilling this obligation and do not comprise a comprehensive risk assessment.

13 Glossary

Alluvium	Sediment laid down by a river. Can range from sands and gravels deposited by fast flowing water and clays that settle out of suspension during overbank flooding. Other deposits found on a valley floor are usually included in the term alluvium (e.g. peat).
Archaeological Priority Area/Zone	Areas of archaeological priority, significance, potential or other title, often designated by the local authority.
Brickearth	A fine-grained silt believed to have accumulated by a mixture of processes (e.g. wind, slope and freeze-thaw) mostly since the Last Glacial Maximum around 17,000BP.
B.P.	Before Present, conventionally taken to be 1950
Bronze Age	2,000–600 BC
Building recording	Recording of historic buildings (by a competent archaeological organisation) is undertaken *'to document buildings, or parts of buildings, which may be lost as a result of demolition, alteration or neglect',* amongst other reasons. Four levels of recording are defined by Royal Commission on the Historical Monuments of England (RCHME) and English Heritage. Level 1 (basic visual record); Level 2 (descriptive record), Level 3 (analytical record), and Level 4 (comprehensive analytical record)
Built heritage	Upstanding structure of historic interest.
Colluvium	A natural deposit accumulated through the action of rainwash or gravity at the base of a slope.
Conservation area	An area of special architectural or historic interest the character or appearance of which it is desirable to preserve or enhance. Designation by the local authority often includes controls over the demolition of buildings; strengthened controls over minor development; and special provision for the protection of trees.
Cropmarks	Marks visible from the air in growing crops, caused by moisture variation due to subsurface features of possible archaeological origin (i.e. ditches or buried walls).
Cut-and-cover [trench]	Method of construction in which a trench is excavated down from existing ground level and which is subsequently covered over and/or backfilled.
Cut feature	Archaeological feature such as a pit, ditch or well, which has been cut into the then-existing ground surface.
Devensian	The most recent cold stage (glacial) of the Pleistocene. Spanning the period from *c* 70,000 years ago until the start of the Holocene (10,000 years ago). Climate fluctuated within the Devensian, as it did in other glacials and interglacials. It is associated with the demise of the Neanderthals and the expansion of modern humans.
Early medieval	AD 410 – 1066. Also referred to as the Saxon period.
Evaluation (archaeological)	A limited programme of non–intrusive and/or intrusive fieldwork which determines the presence or absence of archaeological features, structures, deposits, artefacts or ecofacts within a specified area.
Excavation (archaeological)	A programme of controlled, intrusive fieldwork with defined research objectives which examines, records and interprets archaeological remains, retrieves artefacts, ecofacts and other remains within a specified area. The records made and objects gathered are studied and the results published in detail appropriate to the project design.
Findspot	Chance find/antiquarian discovery of artefact. The artefact has no known context, is either residual or indicates an area of archaeological activity.
Geotechnical	Ground investigation, typically in the form of boreholes and/or trial/test pits, carried out for engineering purposes to determine the nature of the subsurface deposits.
Head	Weathered/soliflucted periglacial deposit (i.e. moved downslope through natural processes).
Heritage asset	A building, monument, site, place, area or landscape positively identified as having a degree of significance meriting consideration in planning decisions. Heritage assets are the valued components of the historic environment. They include designated heritage assets and assets identified by the local planning authority (including local listing).
Historic environment assessment	A written document whose purpose is to determine, as far as is reasonably possible from existing records, the nature of the historic environment resource/heritage assets within a specified area.
Historic Environment Record (HER)	Archaeological and built heritage database held and maintained by the County authority. Previously known as the Sites and Monuments Record
Holocene	The most recent epoch (part) of the Quaternary, covering the past 10,000 years during which time a warm interglacial climate has existed. Also referred to as the 'Postglacial' and (in Britain) as the 'Flandrian'.

Iron Age	600 BC – AD 43
Later medieval	AD 1066 – 1500
Last Glacial Maximum	Characterised by the expansion of the last ice sheet to affect the British Isles (around 18,000 years ago), which at its maximum extent covered over two-thirds of the present land area of the country.
Locally listed building	A structure of local architectural and/or historical interest. These are structures that are not included in the Secretary of State's Listing but are considered by the local authority to have architectural and/or historical merit
Listed building	A structure of architectural and/or historical interest. These are included on the Secretary of State's list, which affords statutory protection. These are subdivided into Grades I, II* and II (in descending importance).
Made Ground	Artificial deposit. An archaeologist would differentiate between modern made ground, containing identifiably modern inclusion such as concrete (but not brick or tile), and undated made ground, which may potentially contain deposits of archaeological interest.
Mesolithic	12,000 – 4,000 BC
National Monuments Record (NMR)	National database of archaeological sites, finds and events as maintained by English Heritage in Swindon. Generally not as comprehensive as the county HER.
Neolithic	4,000 – 2,000 BC
Ordnance Datum (OD)	A vertical datum used by Ordnance Survey as the basis for deriving altitudes on maps.
Palaeo-environmental	Related to past environments, i.e. during the prehistoric and later periods. Such remains can be of archaeological interest, and often consist of organic remains such as pollen and plant macro fossils which can be used to reconstruct the past environment.
Palaeolithic	700,000–12,000 BC
Palaeochannel	A former/ancient watercourse
Peat	A build up of organic material in waterlogged areas, producing marshes, fens, mires, blanket and raised bogs. Accumulation is due to inhibited decay in anaerobic conditions.
Pleistocene	Geological period pre-dating the Holocene.
Post-medieval	AD 1500 – present
Preservation by record	Archaeological mitigation strategy where archaeological remains are fully excavated and recorded archaeologically and the results published. For remains of lesser significance, preservation by record might comprise an archaeological watching brief.
Preservation in situ	Archaeological mitigation strategy where nationally important (whether Scheduled or not) archaeological remains are preserved *in situ* for future generations, typically through modifications to design proposals to avoid damage or destruction of such remains.
Registered Historic Parks and Gardens	A site may lie within or contain a registered historic park or garden. The register of these in England is compiled and maintained by English Heritage.
Residual	When used to describe archaeological artefacts, this means not *in situ,* i.e. Found outside the context in which it was originally deposited.
Roman	AD 43 – 410
Scheduled Monument	An ancient monument or archaeological deposits designated by the Secretary of State as a 'Scheduled Ancient Monument' and protected under the Ancient Monuments Act.
Site	The area of proposed development
Site codes	Unique identifying codes allocated to archaeological fieldwork sites, e.g. evaluation, excavation, or watching brief sites.
Study area	Defined area surrounding the proposed development in which archaeological data is collected and analysed in order to set the site into its archaeological and historical context.
Solifluction, Soliflucted	Creeping of soil down a slope during periods of freeze and thaw in periglacial environments. Such material can seal and protect earlier landsurfaces and archaeological deposits which might otherwise not survive later erosion.
Stratigraphy	A term used to define a sequence of visually distinct horizontal layers (strata), one above another, which form the material remains of past cultures.
Truncate	Partially or wholly remove. In archaeological terms remains may have been truncated by previous construction activity.
Watching brief (archaeological)	An archaeological watching brief is '*a formal programme of observation and investigation conducted during any operation carried out for non–archaeological reasons.*'

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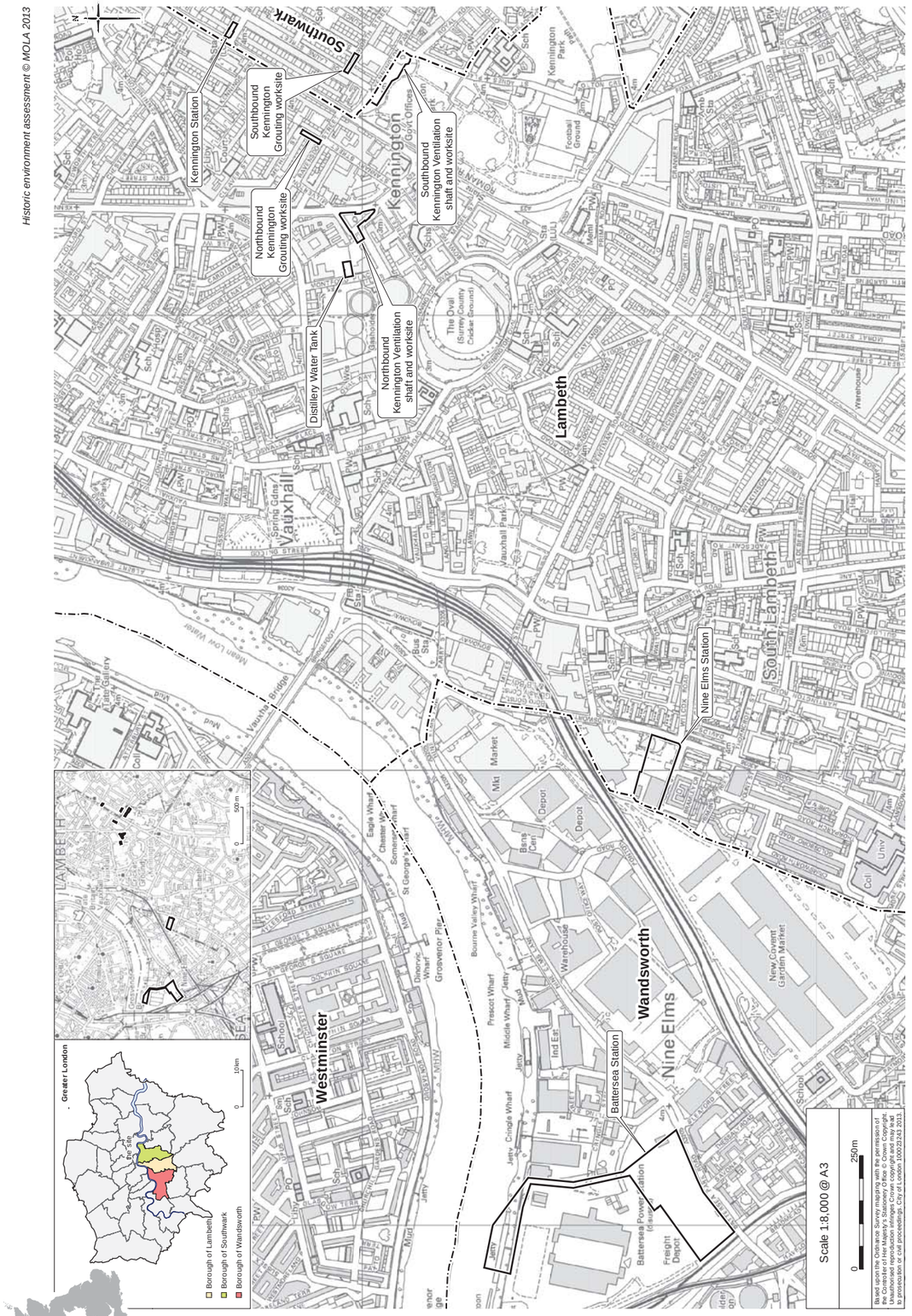

Fig 1 Site location

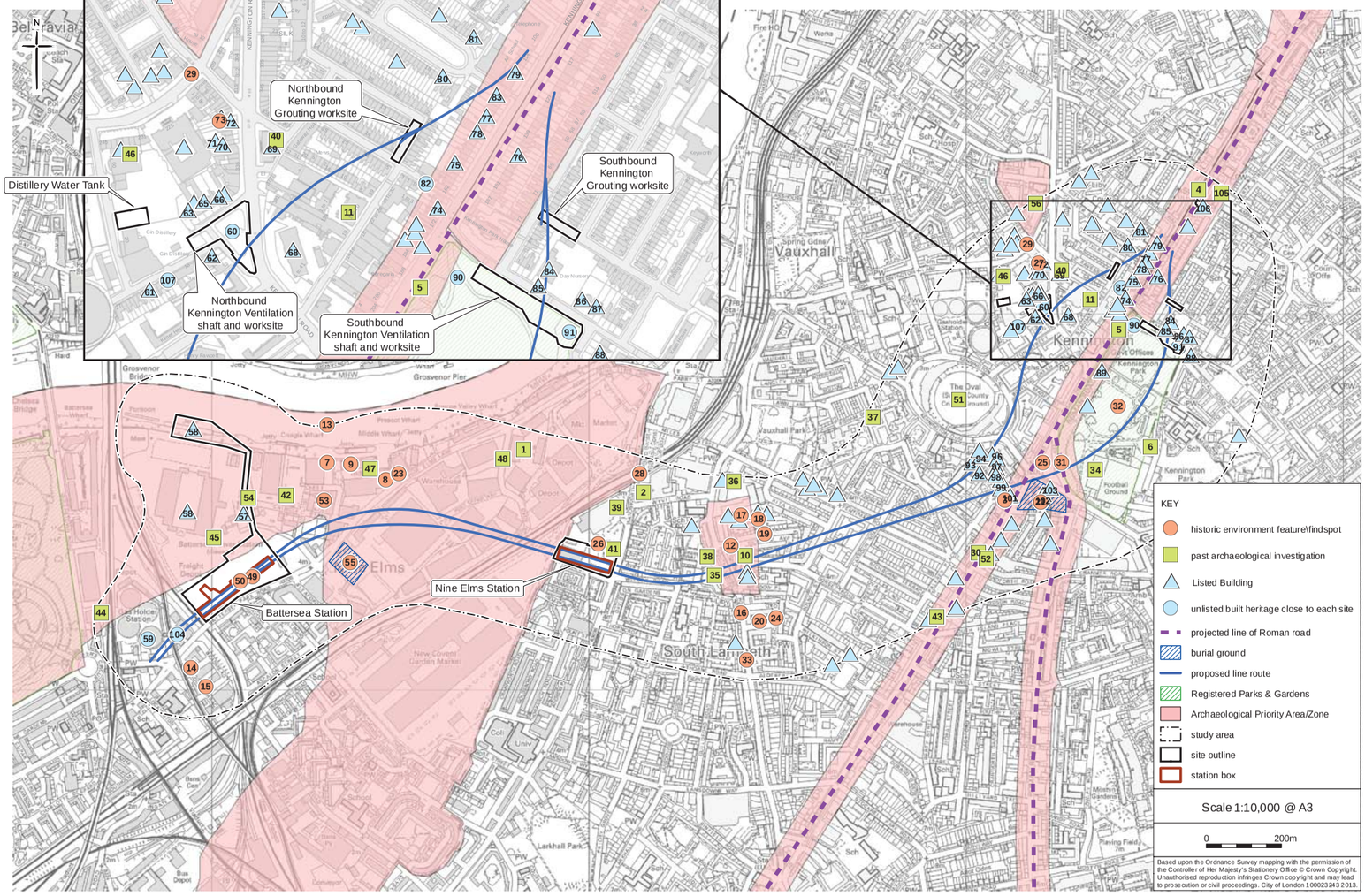

Fig 2 Historic environment features map

WAND1150HEA13#02

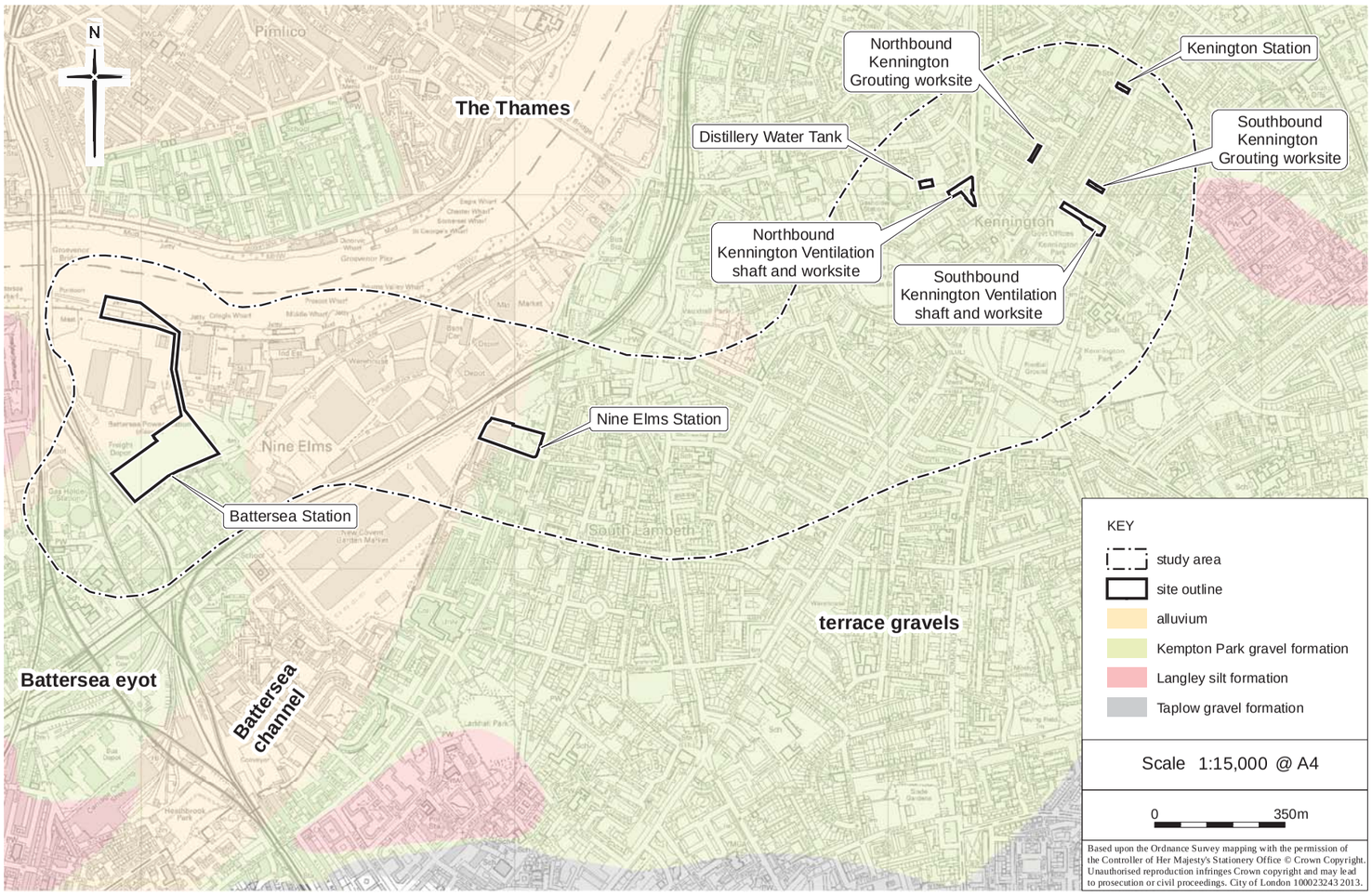

Fig 3 Geological map of the study area

WAND1150HEA13#03

Historic environment assessment © MOLA 2013

Fig 4 Roque's map of 1746

Fig 5 Ordnance Survey 1":mile map of 1822 (not to scale)

Historic environment assessment © MOLA 2013

Fig 6 Stanford's map of 1862

Historic environment assessment © MOLA 2013

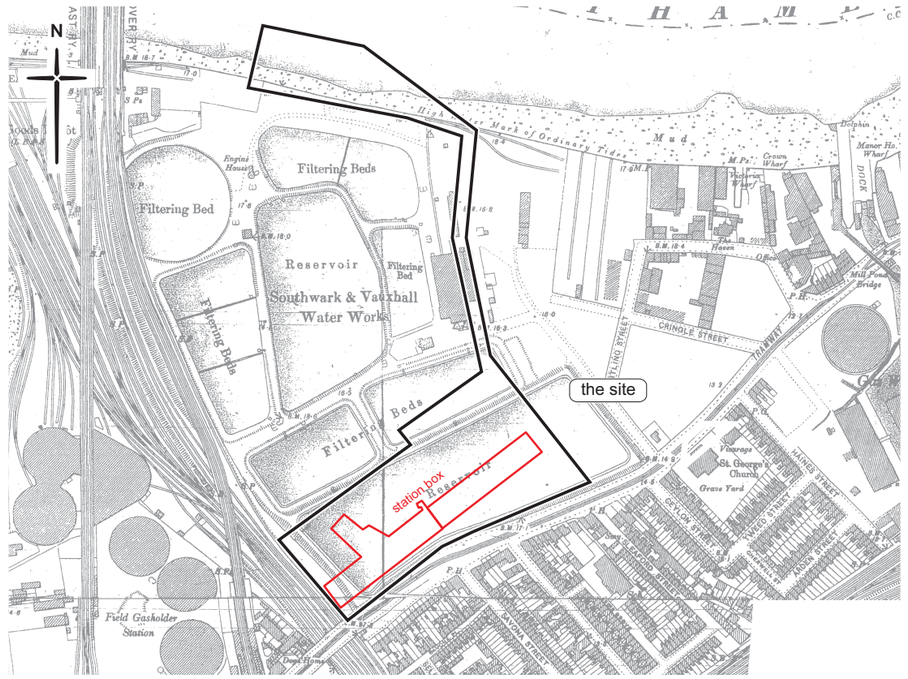

Fig 7 Ordnance Survey 2nd edition 25":mile map of 1897, Battersea Station site (not to scale)

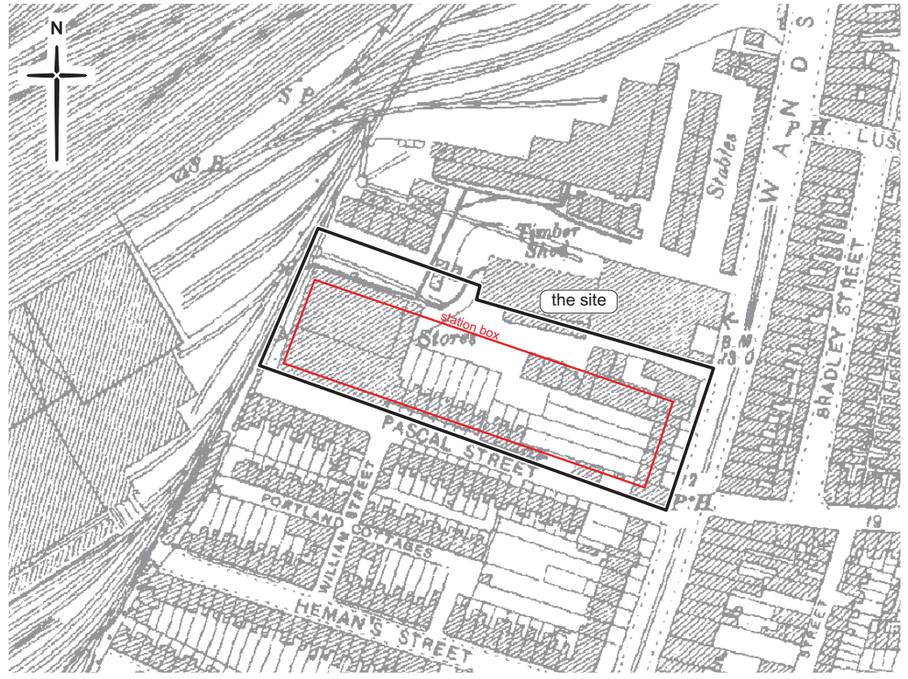

Fig 8 Ordnance Survey 2nd edition 25":mile map of 1894, Nine Elms Station site (not to scale)

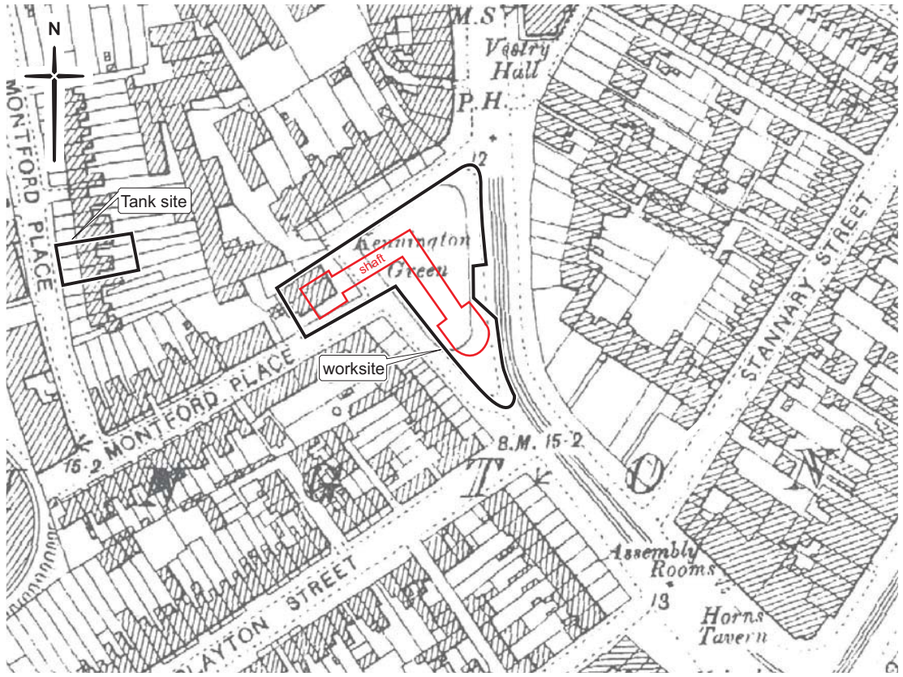

Fig 9 Ordnance Survey 2nd edition 25":mile map of 1894 (not to scale), Northbound Kennington Green Loop TBM Removal / Ventilation Shaft and worksite

Fig 10 Ordnance Survey 2nd edition 25":mile map of 1894 (not to scale), Northbound temporary Grouting Shaft and worksite at Radcot Street

Fig 11 Ordnance Survey 2nd edition 25":mile map of 1894 (not to scale), Southbound Kennington Park Loop TBM Removal / Ventilation Shaft and worksite

Fig 12 Ordnance Survey 2nd edition 25":mile map of 1894 (not to scale), temporary Grouting Shaft and worksite at Harmsworth Street

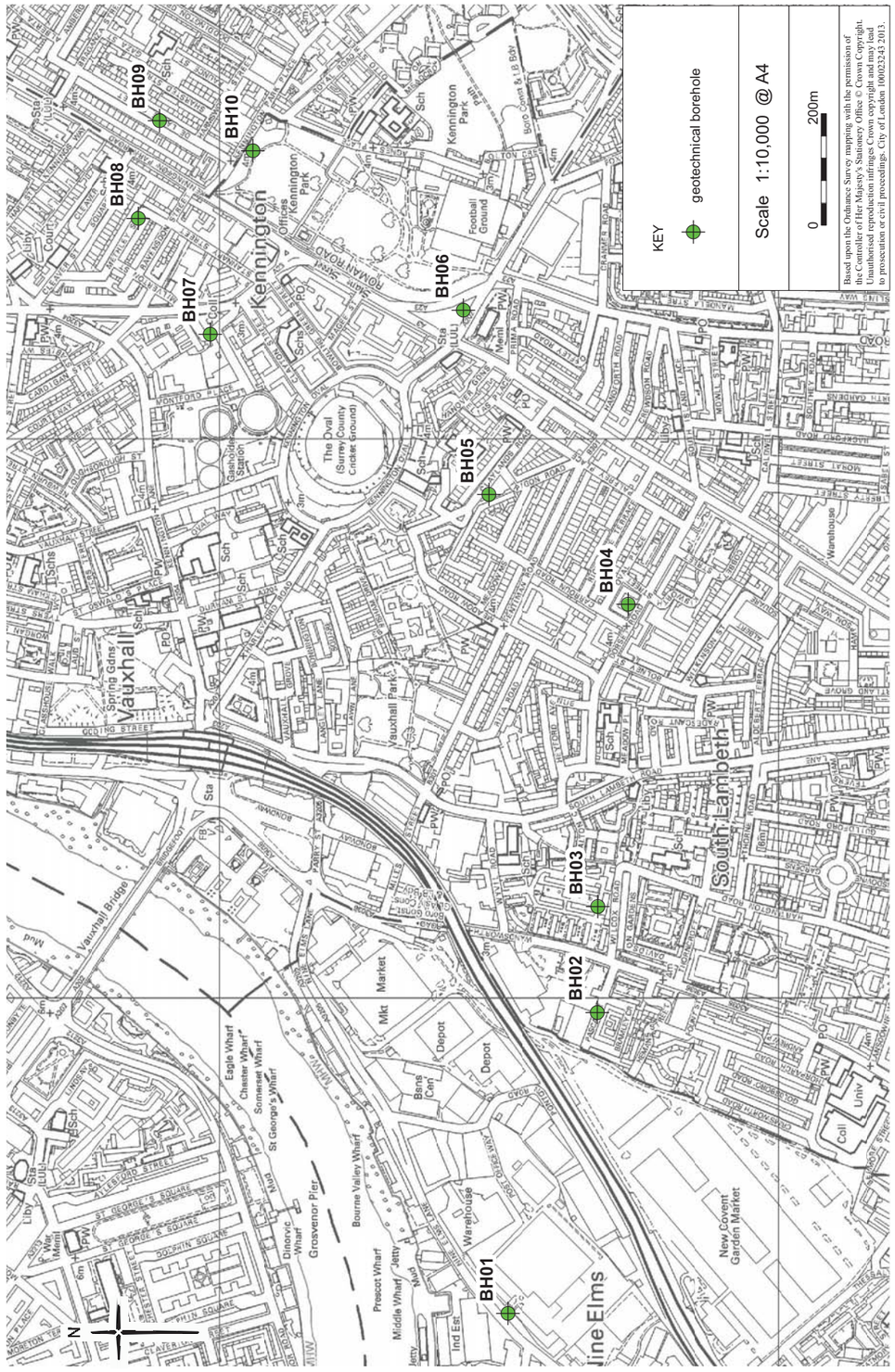

Fig 13 Location map of 2010 geotechnical investigations (Concept Site Investigations: Dwg. 10/2254, June 2010)

Fig 14 Battersea Power Station looking north-west over Box and Crossover site, taken 16-04-2012

Fig 15 Nine Elms Station Box site on Pascal Street, taken 16-04-2012

E: Noise and Vibration

Environmental Statement

Volume II

E1: Baseline Noise Survey Report

Environmental Statement

Volume II

Baseline Noise Survey Report

Northern Line Extension
Environmental Statement
Appendix E1

Final

April 2013

Prepared for:
Transport for London

UNITED KINGDOM & IRELAND

REVISION SCHEDULE					
Rev	**Date**	**Details**	**Prepared by**	**Reviewed by**	**Approved by**
1	April 2013	Final	Steve Cawser Senior Noise and Vibration Consultant	Alf Maneylaws Associate	Paul Shields Head of Acoustics

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TABLE OF CONTENTS

1 INTRODUCTION

URS has undertaken baseline noise surveys in the vicinity of proposed shafts and stations serving the Northern Line extension. The purpose of the surveys was to provide noise data from which to derive noise assessment criteria.

2 NOISE SURVEYS

Long-term and short-term noise monitoring was undertaken at the proposed locations for each shaft and station. Long-term unattended noise monitoring was carried out at each shaft and station site between April 2008 and September 2010. Short-term noise surveys were undertaken in January and March 2013.

Noise measurements were taken in accordance with the requirements of BS 7445-1: 2003.

The sound level meters were set to measure various parameters, including the $L_{Aeq,T}$ and L_{A90} values, logging in periods of 5 or 10 minutes during the daytime, and five minutes at night. All noise measurements were taken at between 1.2 and 1.5 metres above local ground level, and located at least 3.5 metres from any vertical reflecting surfaces. The calibration level of all equipment was checked before and after the monitoring periods and no significant changes were noted.

A map showing the noise monitoring locations can be seen in Figure 1 at the end of this document.

2.1 Noise Sources

2.1.1 *Battersea Station*

Long-term noise measurements (L1 and L2) in April and May 2008 and short-term noise measurements (S1, S2, and S3) in March 2013 were carried out in the proximity of the Battersea station site.

The noise environment is dominated by road traffic on the local road network, primarily Battersea Park Road and Nine Elms Lane. Other significant noise sources include overhead aircraft movements, noise along the western site boundary from rail traffic on the train line connecting Wandsworth Road station and Victoria station, and the neighbouring Waste Transfer Station (WTS) at Cringle Dock on the northeast boundary of the site.

2.1.2 *Nine Elms Station*

Long-term noise measurements (L3) in July 2010 and short-term noise measurements (S4, S5, and S6) in March 2013 were carried out in the proximity of the proposed Nine Elms station site.

The noise environment at the measurement locations is dominated by road traffic on Pascal Street, Wilcox Road, and Wandsworth Road. Other significant noise sources include overhead aircraft movements, noise along the western site boundary from rail traffic on the train line connecting Vauxhall station and Queenstown Road station, and car parking in New Covent Garden Market.

2.1.3 ***Kennington Park Ventilation Shaft***

Long-term noise measurements (L4) in August 2010 and short-term noise measurements (S7, S8, and S14) in March 2013 were carried out in the proximity to the Kennington Park ventilation shaft.

The noise environment at the measurement locations is dominated by road traffic on the local road network. The most direct contribution to the noise measurements originates from traffic on the road directly adjacent to the monitoring locations; however, the most significant contribution to the general soundscape of the area is from road traffic on Kennington Park Place and Kennington Park Road. Other significant noise sources include overhead aircraft movements.

2.1.4 ***Kennington Green Ventilation Shaft***

Long-term noise measurements (L5) in September 2010 and short-term noise measurements (S12, and S13) in March 2013 were carried out in the proximity of the site of the Kennington Green ventilation shaft.

The noise environment at the measurement locations is dominated by road traffic noise from Kennington Road and Kennington Park Road. Other significant noise sources include overhead aircraft movements.

2.1.5 ***Harmsworth Street***

Short-term noise measurements (S9) in March 2013 were carried out in the proximity of the proposed Harmsworth Street shaft.

The noise environment at the measurement locations is dominated by road traffic noise from local roads. Other significant noise sources include overhead aircraft movements.

2.1.6 ***Radcot Street***

Short-term noise measurements (S10 and S11) in March 2013 were carried out in the proximity of the proposed Radcot Street shaft.

The noise environment at the measurement locations is dominated by road traffic noise from local roads. Other significant noise sources include overhead aircraft movements.

2.2 Weather Conditions

Weather conditions (taken from the Wunderground website) during short-term noise measurements which took place on 15th January 2013, 5th, 6th and 19th March 2013 are presented in Table 1.

TABLE 1: SHORT-TERM MONITORING WEATHER CONDITIONS

Date	Temperature	Wind Speed (m/s)	Precipitation (mm)
15/01/13	0°C	3	0.0
05/03/13	8°C	2	0.0
06/03/13	10°C	2	0.2
19/03/13	4°C	4	1.1

The weather conditions (taken from the Wunderground website) prevailing during the long-term noise measurements are provided in Table 2.

TABLE 2: LONG-TERM MONITORING WEATHER CONDITIONS

Date	Temperature	Wind Speed (m/s)	Precipitation (mm)
LT1 & LT2 Monitoring Period			
25/04/2008	12°C	4	0.0
26/04/2008	14°C	3	0.0
27/04/2008	14°C	3	1.0
28/04/2008	12°C	4	3.0
29/04/2008	8°C	3	5.0
30/04/2008	8°C	4	10.0
01/05/2008	11°C	5	3.0
02/05/2008	10°C	2	1.0
03/05/2008	12°C	3	0.0
04/05/2008	17°C	3	0.0
05/05/2008	18°C	3	0.0
06/05/2008	16°C	3	0.0
07/05/2008	18°C	3	0.0
08/05/2008	18°C	4	0.0
09/05/2008	19°C	2	0.4
LT3 Monitoring Period			
27/07/2010	21	3	0.0
28/07/2010	20	4	0.0
29/07/2010	18	3	0.0

TABLE 2: LONG-TERM MONITORING WEATHER CONDITIONS			
Date	**Temperature**	**Wind Speed (m/s)**	**Precipitation (mm)**
30/07/2010	20	3	0.0
31/07/2010	21	3	0.0
01/08/2010	18	3	0.0
02/08/2010	19	2	0.0
03/08/2010	18	3	0.0
LT4 Monitoring Period			
03/08/2010	18°C	3	0.0
04/08/2010	17°C	4	3.0
05/08/2010	16°C	4	0.2
06/08/2010	16°C	3	0.0
07/08/2010	18°C	4	1.0
08/08/2010	18°C	2	0.0
09/08/2010	20°C	4	0.0
10/08/2010	16°C	4	6.0
LT5 Monitoring Period			
09/09/2010	17°C	3	0.2
10/09/2010	18°C	4	0.0
11/09/2010	18°C	5	0.2
12/09/2010	16°C	3	0.0
13/09/2010	14°C	4	0.0
14/09/2010	16°C	6	0.8

2.3 Methodology

Measured noise levels have been used to set assessment criteria for the assessment of the impact of construction noise and the impact of fixed plant noise associated with the operational NLE scheme.

Long-term background noise measurements were analysed to derive hourly average daytime and night-time L_{A90} noise levels for weekdays and weekends; the lowest of which is used to derive background noise levels for assessing the noise impact of fixed plant associated with

the operational NLE scheme. This method is based on the Crossrail method for the determination of the background[1].

Design criteria for plant associated with the operational NLE scheme have been derived at each site using guidance within BS 4142 and lowest measured $L_{A90,1h}$ noise levels during the daytime and night-time period.

Construction noise assessment criteria have been derived using daytime, evening, and night-time $L_{Aeq,T}$ measured noise levels in accordance with guidance within BS 5228-1:2009. The day, evening, and night periods are derived as follows:

- Daytime – Weekdays 07:00 to 19:00 and Saturdays 07:00 to 13:00;
- Evening and Weekends – Weekdays 19:00 to 23:00, Saturdays 13:00 to 23:00 and Sundays 07:00 to 23:00; and
- Night-time – 23:00 to 07:00.

2.4 Battersea Station Noise Measurements Results

The results of the long-term noise measurements at locations L1 and L2 are presented in Tables 3 and 4. Figures 2 and 3, presented at the end of this document, show noise plots for the duration of the long-term measurements. Table 29 and Table 30, found at the end of this document, show the hourly measured L_{A90} values (calculated by arithmetically averaging 12 $L_{A90,5min}$ values) during the long-term monitoring periods. The results of short-term measurements at locations S1, S2, and S3 are presented in Tables 5, 6, and 7.

TABLE 3: BASELINE NOISE SURVEY RESULTS (L1)			
Date	**Day - L_{Aeq} (dB)**	**Evening & Weekend - L_{Aeq} (dB)**	**Night - L_{Aeq} (dB)**
26/04/2008	62	62	60
27/04/2008	-	62	59
28/04/2008	64	62	60
29/04/2008	63	62	59
30/04/2008	61	63	60
01/05/2008	64	61	61
02/05/2008	64	61	60
03/05/2008	61	60	59
04/05/2008	-	59	57
05/05/2008	59	60	57
06/05/2008	62	61	59

[1] CRL1-XRL-T1-GPD-CRG03-50002 Method for Establishing Background Noise Levels for Fixed Installation Assessments, Rev 0, 04/05/12

TABLE 3: BASELINE NOISE SURVEY RESULTS (L1)			
Date	**Day - L_{Aeq} (dB)**	**Evening & Weekend - L_{Aeq} (dB)**	**Night - L_{Aeq} (dB)**
07/05/2008	62	62	59
08/05/2008	63	61	59
09/05/2008	-	-	59
Average	62	61	59

TABLE 4: BASELINE NOISE SURVEY RESULTS (L2)			
Date	**Day - L_{Aeq} (dB)**	**Evening & Weekend - L_{Aeq} (dB)**	**Night - L_{Aeq} (dB)**
26/04/2008	62	60	55
27/04/2008	-	60	55
28/04/2008	61	59	56
29/04/2008	61	58	54
30/04/2008	62	58	54
01/05/2008	62	58	58
02/05/2008	62	60	55
03/05/2008	60	57	56
04/05/2008	-	57	52
05/05/2008	57	55	54
06/05/2008	60	58	55
07/05/2008	59	57	54
08/05/2008	60	57	55
09/05/2008	-	-	55
Average	61	58	55

TABLE 5: BASELINE NOISE SURVEY RESULTS (S1)			
Date & Time	**Duration (minutes)**	**Free-Field Ambient Level dB L_{Aeq}**	**Background Level dB L_{A90}**
05/03/2013 12:10	10	74	64
05/03/2013 13:45	10	73	62
05/03/2013 15:34	10	74	66
06/03/2013 00:43	5	69	51
06/03/2013 01:43	5	69	51
06/03/2013 02:45	5	68	48

TABLE 6: BASELINE NOISE SURVEY RESULTS (S2)			
Date & Time	**Duration (minutes)**	**Free-Field Ambient Level dB L_{Aeq}**	**Background Level dB L_{A90}**
05/03/2013 12:24	10	72	64
05/03/2013 14:00	10	72	62
05/03/2013 15:46	10	73	61
06/03/2013 00:51	5	69	45
06/03/2013 01:51	5	68	42
06/03/2013 02:52	5	67	41

TABLE 7: BASELINE NOISE SURVEY RESULTS (S3)			
Date & Time	**Duration (minutes)**	**Free-Field Ambient Level dB L_{Aeq}**	**Background Level dB L_{A90}**
05/03/2013 12:38	10	74	64
05/03/2013 14:12	10	74	64
05/03/2013 15:58	10	75	65
06/03/2013 00:58	5	71	47
06/03/2013 01:58	5	70	50
06/03/2013 02:59	5	68	44

2.5 Nine Elms Station Noise Measurements Results

The results of the long-term noise measurements at location L3 are presented in Table 8. Figure 4, presented at the end of this document, shows a noise plot for the duration of the long-term measurements. Table 31, found at the end of this document, shows the hourly

measured L_{A90} values (calculated by arithmetically averaging 12 $L_{A90,5min}$ values) during the long-term monitoring period. The results of short-term measurements at locations S4, S5, and S6 are presented in Tables 9, 10, and 11.

TABLE 8: BASELINE NOISE SURVEY RESULTS (L3)

Date	Day - L_{Aeq} (dB)	Evening & Weekend - L_{Aeq} (dB)	Night - L_{Aeq} (dB)
28/07/2010	55	58	52
29/07/2010	58	57	52
30/07/2010	57	57	51
31/07/2010	56	58	50
01/08/2010	61	57	53
02/08/2010	64	64	52
03/08/2010	-	-	53
Average	59	59	52

TABLE 9: BASELINE NOISE SURVEY RESULTS (S4)

Date & Time	Duration (minutes)	Free-Field Ambient Level dB L_{Aeq}	Background Level dB L_{A90}
05/03/2013 13:15	10	54	47
05/03/2013 15:02	10	54	47
05/03/2013 16:36	10	56	47
06/03/2013 01:21	5	52	43
06/03/2013 02:23	5	49	38
06/03/2013 03:22	5	50	39
19/03/2013 20:05	5	50	46
19/03/2013 20:10	5	51	43
19/03/2013 20:15	5	56	47

TABLE 10: BASELINE NOISE SURVEY RESULTS (S5)

Date & Time	Duration (minutes)	Free-Field Ambient Level dB L_{Aeq}	Background Level dB L_{A90}
15/01/2013 12:40	5	60	51
15/01/2013 12:45	5	58	48
15/01/2013 12:50	5	59	50
15/01/2013 12:55	5	54	45
15/01/2013 13:00	5	58	45
15/01/2013 13:05	5	57	47
15/01/2013 14:05	5	57	44
15/01/2013 14:10	5	57	45
15/01/2013 14:15	5	58	44
15/01/2013 14:20	5	59	47
15/01/2013 14:25	5	57	46
15/01/2013 14:30	5	58	45

TABLE 11: BASELINE NOISE SURVEY RESULTS (S6)

Date & Time	Duration (minutes)	Free-Field Ambient Level dB L_{Aeq}	Background Level dB L_{A90}
15/01/2013 12:05	5	64	58
15/01/2013 12:10	5	64	56
15/01/2013 12:15	5	63	55
15/01/2013 12:20	5	65	54
15/01/2013 12:25	5	65	54
15/01/2013 12:30	5	64	57
15/01/2013 13:30	5	66	58
15/01/2013 13:35	5	64	56
15/01/2013 13:40	5	68	53
15/01/2013 13:45	5	64	57
15/01/2013 13:50	5	65	57
15/01/2013 13:55	5	65	56

2.6 Kennington Park Noise Measurement Results

The results of the long-term noise measurements at location L4 are presented in Table 12. Figure 5, presented at the end of this document, shows a noise plot for the duration of the long-term measurement period. Table 32, found at the end of this document, shows the hourly measured L_{A90} values (calculated by arithmetically averaging 12 $L_{A90,5min}$ values) during the long-term monitoring period. The results of short-term measurements at locations S7, S8, and S14 are presented in Tables 13, 14, and 15.

TABLE 12: BASELINE NOISE SURVEY RESULTS (L4)

Date	Day - L_{Aeq} (dB)	Evening & Weekend - L_{Aeq} (dB)	Night - L_{Aeq} (dB)
04/08/2010	58	55	52
05/08/2010	58	53	54
06/08/2010	60	52	53
07/08/2010	58	55	53
08/08/2010	-	55	53
09/08/2010	57	57	53
10/08/2010	56	56	50
11/08/2010	56	57	52
12/08/2010	57	57	52
Average	58	56	53

TABLE 13: BASELINE NOISE SURVEY RESULTS (S7)

Date & Time	Duration (minutes)	Free-Field Ambient Level dB L_{Aeq}	Background Level dB L_{A90}
05/03/2013 12:48	10	60	52
05/03/2013 14:31	10	62	52
05/03/2013 16:25	10	66	53
06/03/2013 00:22	5	49	44
06/03/2013 01:24	5	49	43
06/03/2013 02:29	5	51	41

TABLE 14: BASELINE NOISE SURVEY RESULTS (S8)

Date & Time	Duration (minutes)	Free-Field Ambient Level dB L_{Aeq}	Background Level dB L_{A90}
05/03/2013 12:33	10	62	48
05/03/2013 14:44	10	60	47
05/03/2013 16:39	10	60	47
06/03/2013 00:14	5	43	39
06/03/2013 01:16	5	56	39
06/03/2013 02:21	5	43	38
19/03/2013 22:32	5	52	41
19/03/2013 22:37	5	48	39
19/03/2013 22:42	5	49	40

TABLE 15: BASELINE NOISE SURVEY RESULTS (S14)

Date & Time	Duration (minutes)	Free-Field Ambient Level dB L_{Aeq}	Background Level dB L_{A90}
05/03/2013 13:03	10	69	59
05/03/2013 15:16	10	74	58
05/03/2013 17:04	10	71	60
06/03/2013 00:30	5	69	51
06/03/2013 01:32	5	65	49
06/03/2013 02:36	5	64	47

2.7 Kennington Green Noise Measurement Results

The results of the long-term noise measurements at location L5 are presented in Table 16. Figure 6, presented at the end of this document, shows a noise plot for the duration of the long-term measurement period. Table 33, found at the end of this document, shows the hourly measured L_{A90} values (calculated by arithmetically averaging 12 $L_{A90,5min}$ values) during the long-term monitoring period. The results of short-term measurements at locations S12, and S13 are presented in Tables 17 and 18.

TABLE 16: BASELINE NOISE SURVEY RESULTS (L5)			
Date	**Day - L_{Aeq} (dB)**	**Evening & Weekend - L_{Aeq} (dB)**	**Night - L_{Aeq} (dB)**
10/09/2010	80	63	61
11/09/2010	61	63	61
12/09/2010	-	62	61
13/09/2010	68	64	60
14/09/2010	75	-	60
Average	71	62	61

TABLE 17: BASELINE NOISE SURVEY RESULTS (S12)			
Date & Time	**Duration (minutes)**	**Free-Field Ambient Level dB L_{Aeq}**	**Background Level dB L_{A90}**
05/03/2013 13:52	10	72	57
05/03/2013 15:58	10	70	59
05/03/2013 18:20	10	69	59
06/03/2013 00:53	5	66	49
06/03/2013 01:55	5	64	43
06/03/2013 02:59	5	64	44

TABLE 18: BASELINE NOISE SURVEY RESULTS (S13)			
Date & Time	**Duration (minutes)**	**Free-Field Ambient Level dB L_{Aeq}**	**Background Level dB L_{A90}**
05/03/2013 14:03	10	76	61
05/03/2013 16:10	10	70	62
05/03/2013 18:07	10	71	63
06/03/2013 01:00	5	67	50
06/03/2013 02:01	5	65	46
06/03/2013 03:05	5	67	51

2.8 Harmsworth Street Noise Measurements

The results of short-term measurements at location S9 are presented in Table 19.

TABLE 19: BASELINE NOISE SURVEY RESULTS (S9)			
Date & Time	**Duration (minutes)**	**Free-Field Ambient Level dB L_{Aeq}**	**Background Level dB L_{A90}**
05/03/2013 12:19	10	67	56
05/03/2013 14:59	10	65	54
05/03/2013 16:52	10	66	57
06/03/2013 00:06	5	60	49
06/03/2013 01:09	5	52	45
06/03/2013 02:14	5	51	43

2.9 Radcot Street Noise Measurements

The results of short-term measurements at locations S10 and S11 are presented in Tables 20 and 21.

TABLE 20: BASELINE NOISE SURVEY RESULTS (S10)			
Date & Time	**Duration (minutes)**	**Free-Field Ambient Level dB L_{Aeq}**	**Background Level dB L_{A90}**
05/03/2013 13:32	10	57	45
05/03/2013 15:44	10	55	43
05/03/2013 17:33	10	57	46
06/03/2013 00:46	5	52	39
06/03/2013 01:47	5	42	36
06/03/2013 02:51	5	43	37
19/03/2013 22:08	5	45	41
19/03/2013 22:13	5	47	41
19/03/2013 22:18	5	47	41

TABLE 21: BASELINE NOISE SURVEY RESULTS (S11)			
Date & Time	**Duration (minutes)**	**Free-Field Ambient Level dB L_{Aeq}**	**Background Level dB L_{A90}**
05/03/2013 13:18	10	57	49
05/03/2013 15:31	10	59	53
05/03/2013 17:20	10	69	56
06/03/2013 00:38	5	53	40
06/03/2013 01:40	5	52	36
06/03/2013 02:43	5	52	37

3 SUMMARY

The background noise levels provided in the following tables are, for short-term measurements, the lowest measured $L_{A90,5min}$. For the long-term measurements, the separate $L_{A90,5min}$ data for each hour have been averaged to produce an average $L_{A90,5min}$ for that hour. These have then been averaged for each hour across the days to provide a separate average L_{A90} for each of the 24 hours in a day. The lowest of these average L_{A90} values for each of the day (07:00-23:00) and night (23:00-07:00) periods have been used in the summary tables.

A summary of noise measurements taken at locations in the Battersea station area (presented in Tables 3 to 7) can be seen in Table 22 below.

TABLE 22: BATTERSEA STATION NOISE MEASUREMENT SUMMARY					
Location	**Average Ambient Free-Field dB $L_{Aeq,T}$**			**Background Noise dB $L_{A90,T}$**	
	Daytime (07:00 – 19:00) and Saturdays (07:00 – 13:00)	**Evenings (1900 – 2300) and Weekends**	**Night (2300 – 0700)**	**Daytime**	**Night-time**
				07:00 – 23:00 (T = 16hr)	**23:00 – 07:00 (T = 8hr)**
L1	62	61	59	51*	45*
L2	61	58	55	48*	43*
S1	74	-	68	62	48
S2	72	-	68	61	41
S3	74	-	70	64	44
* Represents lowest hourly average L_{A90} for each day and each night period					

A summary of noise measurements taken at locations in the Nine Elms station area (presented in Tables 8 to 11) can be seen in Table 23 below.

TABLE 23: NINE ELMS STATION NOISE MEASUREMENT SUMMARY					
Location	**Average Ambient Free-Field dB $L_{Aeq,T}$**			**Background Noise dB $L_{A90,T}$**	
	Daytime (07:00 – 19:00) and Saturdays (07:00 – 13:00)	**Evenings (1900 – 2300) and Weekends**	**Night (2300 – 0700)**	**Daytime**	**Night-time**
				07:00 – 23:00 (T = 16hr)	**23:00 – 07:00 (T = 8hr)**
L3	59	59	52	47*	44*
S4	55	53	50	43	38
S5	58	-	-	44	-
S6	65	-	-	53	-
* Represents lowest hourly average L_{A90} for each day and each night period					

A summary of noise measurements taken at locations in the Kennington Park area (presented in Tables 12 to 15) can be seen in Table 24 below.

TABLE 24: KENNINGTON PARK NOISE MEASUREMENT SUMMARY					
Location	**Average Ambient Free-Field dB $L_{Aeq,T}$**			**Background Noise dB $L_{A90,T}$**	
	Daytime (07:00 – 19:00) and Saturdays (07:00 – 13:00)	**Evenings (1900 – 2300) and Weekends**	**Night (2300 – 0700)**	**Daytime**	**Night-time**
				07:00 – 23:00 (T = 16hr)	**23:00 – 07:00 (T = 8hr)**
L4	58	55	52	49*	44*
S7	63	-	50	52	41
S8	61	50	52	39	38
S14	71	-	66	58	47
* Represents lowest hourly average L_{A90} for each day and each night period					

A summary of noise measurements taken at locations in the Kennington Green area (presented in Tables 16 to 18) can be seen in Table 25 below.

TABLE 25: KENNINGTON GREEN NOISE MEASUREMENT SUMMARY

Location	Average Ambient Free-Field dB $L_{Aeq,T}$			Background Noise dB $L_{A90,T}$	
	Daytime (07:00 – 19:00) and Saturdays (07:00 – 13:00)	Evenings (1900 – 2300) and Weekends	Night (2300 – 0700)	Daytime 07:00 – 23:00 (T = 16hr)	Night-time 23:00 – 07:00 (T = 8hr)
L5	71	63	61	51*	39*
S12	71	-	65	57	43
S13	73	-	66	61	46

* Represents lowest hourly average L_{A90} for each day and each night period

A summary of noise measurements taken at locations in the Harmsworth Street area (presented in Tables 19 to 20) can be seen in Table 26 below.

TABLE 26: HARMSWORTH STREET NOISE MEASUREMENT SUMMARY

Location	Average Ambient Free-Field dB $L_{Aeq,T}$			Background Noise dB $L_{A90,5min}$	
	Daytime (07:00 – 19:00) and Saturdays (07:00 – 13:00)	Evenings (1900 – 2300) and Weekends	Night (2300 – 0700)	Daytime 07:00 – 23:00 (T = 16hr)	Night-time 23:00 – 07:00 (T = 8hr)
S9	66	-	56	54	43

A summary of noise measurements taken at locations in the Radcot Street area (presented in Table 21) can be seen in Table 27 below.

TABLE 27: RADCOT STREET NOISE MEASUREMENT SUMMARY

Location	Average Ambient Free-Field dB $L_{Aeq,T}$			Background Noise dB $L_{A90,5min}$	
	Daytime (07:00 – 19:00) and Saturdays (07:00 – 13:00)	Evenings (1900 – 2300) and Weekends	Night (2300 – 0700)	Daytime 07:00 – 23:00 (T = 16hr)	Night-time 23:00 – 07:00 (T = 8hr)
S10	56	46	48	41	36
S11	65	-	53	49	36

A summary of measured long-term $L_{A90,1h}$ background noise levels can be seen in Table 28 below.

TABLE 28: BACKGROUND NOISE SURVEY RESULTS

Site	Location	Period	$L_{A90,1h}$ Background Noise Level (dB)	
			Daytime	Night-time
Battersea Station	L1	Weekday	54	45
		Weekend	51	46
	L2	Weekday	49	43
		Weekend	48	44
Nine Elms	L3	Weekday	50	46
		Weekend	47	44
Kennington Park	L4	Weekday	50	44
		Weekend	49	47
Kennington Green	L5	Weekday	52	39
		Weekend	51	45

Figure 1: Noise Monitoring Locations

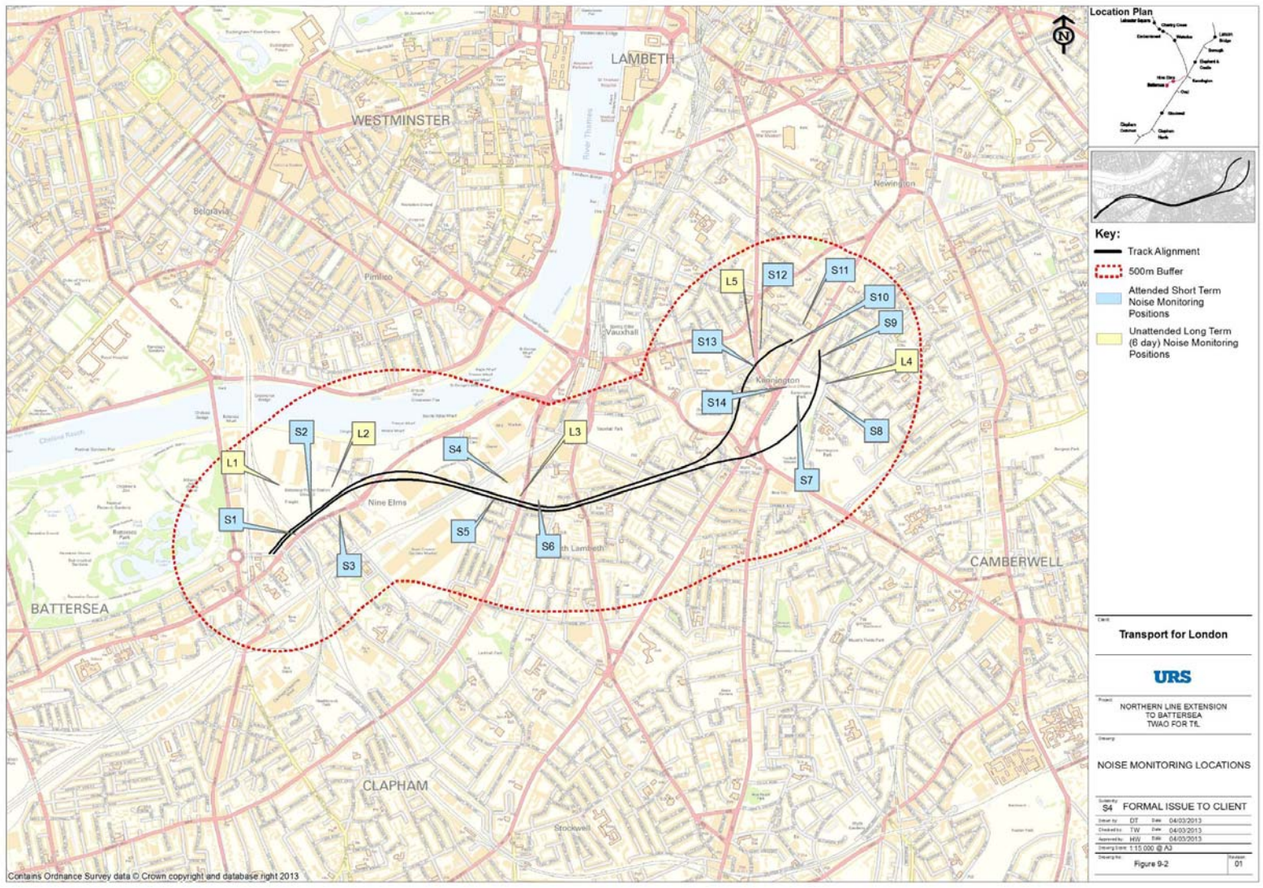

Figure 2: Long-Term Noise Data (Position L1)

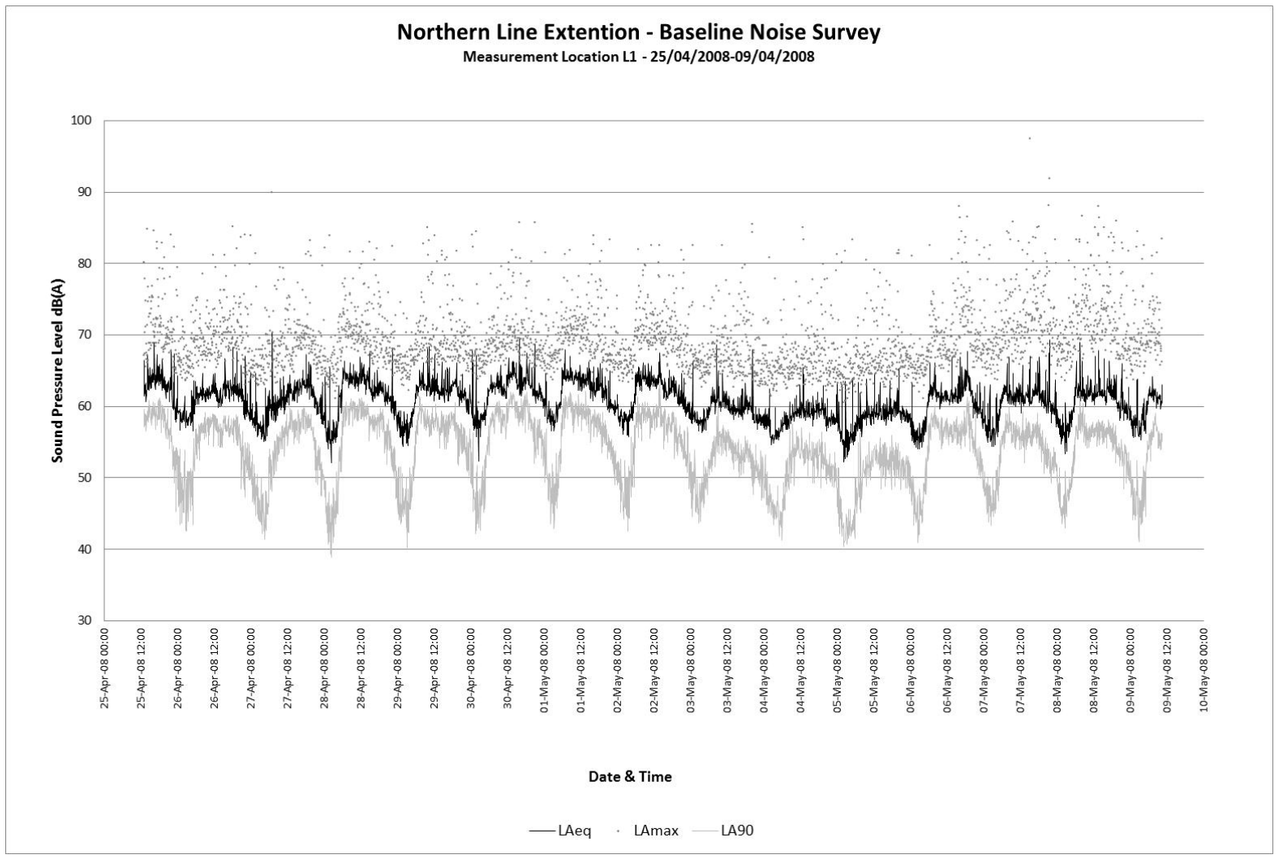

TABLE 29: MEASURED $L_{A90,1h}$ NOISE LEVELS (L1)

Period		$L_{A90,1h}$ Noise Levels (dB)																							
		00:00	01:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
Saturday	26/04/2008	50	48	48	48	49	51	55	56	57	58	57	58	58	57	56	58	57	57	57	57	56	53	52	52
Sunday	27/04/2008	50	48	47	45	45	46	52	52	54	55	56	57	57	58	57	57	58	58	58	58	56	53	52	50
Monday	28/04/2008	48	44	43	45	48	54	58	59	59	60	59	60	60	59	59	58	58	58	58	57	55	56	52	51
Tuesday	29/04/2008	48	46	47	45	48	52	57	60	59	58	57	58	58	57	57	57	57	58	58	57	56	55	54	53
Wednesday	30/04/2008	51	46	47	47	49	54	57	58	60	59	58	58	60	61	61	59	59	60	60	58	56	56	56	55
Thursday	01/05/2008	53	50	48	47	49	54	59	60	61	59	60	59	59	59	59	58	58	58	57	57	56	54	53	52
Friday	02/05/2008	51	48	47	47	50	53	58	58	59	59	59	58	59	60	59	58	57	57	58	56	56	54	53	53
Saturday	03/05/2008	49	49	46	48	49	50	52	54	55	56	56	55	55	54	54	53	53	53	54	53	51	51	51	50
Sunday	04/05/2008	49	47	47	45	46	44	46	50	51	54	54	54	54	53	54	54	53	53	53	53	51	51	51	51
Monday	05/05/2008	47	45	42	43	43	44	48	50	50	51	52	52	54	53	53	53	52	52	52	52	52	51	51	51
Tuesday	06/05/2008	49	46	44	45	47	52	56	58	58	57	56	57	57	57	57	56	56	57	58	58	55	54	52	52
Wednesday	07/05/2008	49	47	46	47	49	53	56	57	58	56	56	56	56	56	56	56	57	57	56	54	53	52	51	52
Thursday	08/05/2008	49	46	46	47	49	52	56	58	58	56	56	57	56	57	57	56	56	57	56	55	53	53	52	51
Weekday Background		49	46	45	46	48	52	56	58	58	57	57	57	58	58	57	57	57	57	57	56	55	54	53	52
Weekend Background		50	48	47	46	47	48	51	53	54	56	56	56	56	56	55	56	55	55	56	55	54	52	51	51

All times refer start time of the hour which they represent

Figure 3: Long-Term Noise Data (Position L2)

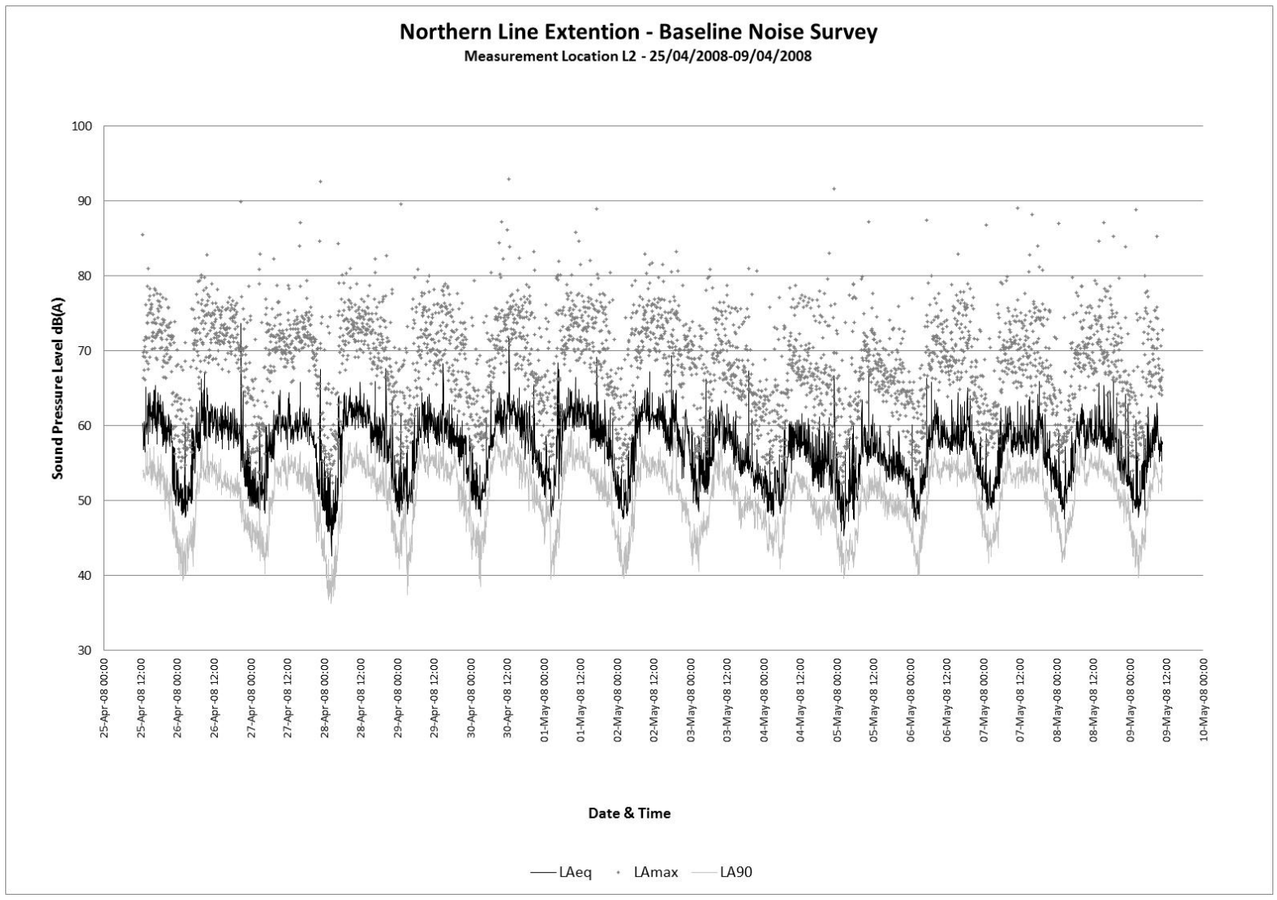

TABLE 30: MEASURED $L_{A90,1h}$ NOISE LEVELS (L2)

Period		$L_{A90,1h}$ Noise Levels (dB)																							
		00:00	01:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
Saturday	26/04/2008	43	42	42	43	45	46	52	53	55	55	54	55	54	53	53	53	52	52	52	52	51	48	47	47
Sunday	27/04/2008	46	45	46	44	43	44	49	51	54	54	54	54	54	55	55	53	54	54	53	53	51	48	48	44
Monday	28/04/2008	43	39	39	41	44	47	53	54	57	55	56	56	55	54	55	54	54	52	52	53	52	51	47	45
Tuesday	29/04/2008	43	45	49	41	44	48	53	55	57	55	55	56	55	54	55	55	54	54	55	54	52	51	49	50
Wednesday	30/04/2008	45	45	45	43	45	49	53	55	58	57	55	55	56	57	57	56	54	54	53	53	51	51	50	48
Thursday	01/05/2008	48	48	43	43	46	48	54	55	57	57	56	56	56	55	55	54	53	53	52	52	51	50	49	46
Friday	02/05/2008	44	42	42	43	45	48	53	54	56	55	54	55	55	54	55	54	53	52	56	54	51	49	49	48
Saturday	03/05/2008	44	45	43	46	47	47	50	52	55	55	55	53	54	52	51	51	49	49	50	50	49	49	49	47
Sunday	04/05/2008	47	45	45	45	46	43	46	50	52	51	53	53	52	52	51	50	49	48	48	49	49	49	48	50
Monday	05/05/2008	44	43	41	43	43	43	46	49	52	51	51	52	52	52	51	51	50	50	49	49	49	49	49	48
Tuesday	06/05/2008	46	44	42	44	47	49	54	55	56	54	54	55	55	54	55	54	53	54	54	55	54	52	50	48
Wednesday	07/05/2008	46	45	44	45	47	50	52	54	55	53	53	54	54	53	54	54	54	53	57	54	50	50	49	49
Thursday	08/05/2008	47	44	44	46	47	49	54	55	55	53	54	55	55	55	55	54	54	53	53	52	50	50	50	49
Weekday Background		45	44	43	43	45	48	52	54	56	54	54	55	55	54	55	54	53	53	54	53	51	50	49	48
Weekend Background		45	44	44	45	45	45	49	52	54	54	54	54	54	53	53	52	51	51	50	51	50	48	48	47

All times refer start time of the hour which they represent

Figure 4: Long-Term Noise Data (Position L3)

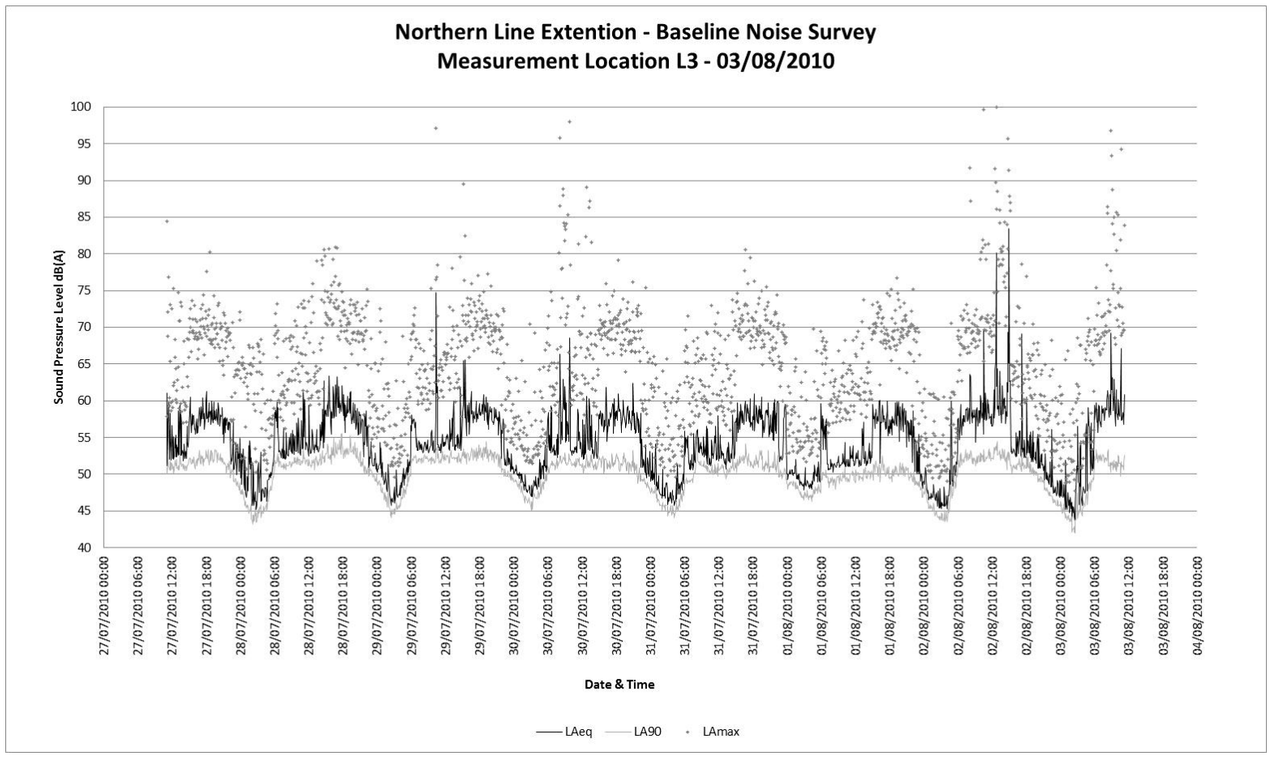

TABLE 31: MEASURED $L_{A90,1h}$ NOISE LEVELS (L3)

Period		$L_{A90,1h}$ Noise Levels (dB)																							
		00:00	01:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
Monday	28/07/2010	47	45	44	45	46	48	52	51	51	52	52	52	51	52	52	53	53	54	53	53	53	51	50	50
Tuesday	29/07/2010	49	47	45	45	47	49	52	52	52	52	52	52	52	52	52	53	53	53	53	53	53	52	50	50
Wednesday	30/07/2010	49	48	46	46	47	49	51	51	52	52	51	52	51	52	51	52	51	52	52	52	51	51	49	48
Thursday	31/07/2010	48	46	46	45	45	47	49	50	52	51	51	51	51	50	51	52	52	52	52	52	51	51	51	50
Friday	01/08/2010	49	49	47	47	47	48	50	49	49	49	50	50	50	50	50	51	51	50	50	51	51	50	49	48
Saturday	02/08/2010	47	45	44	44	46	49	52	52	52	52	52	52	53	53	52	51	51	51	51	50	49	48	47	46
Weekday Background		48	47	46	46	46	48	51	51	51	51	51	51	51	51	51	52	52	52	52	52	52	51	50	49
Weekend Background		47	45	44	44	46	49	52	52	52	52	52	52	53	53	52	51	51	51	51	50	49	48	47	46

All times refer start time of the hour which they represent

Figure 5: Long-Term Noise Data (Position L4)

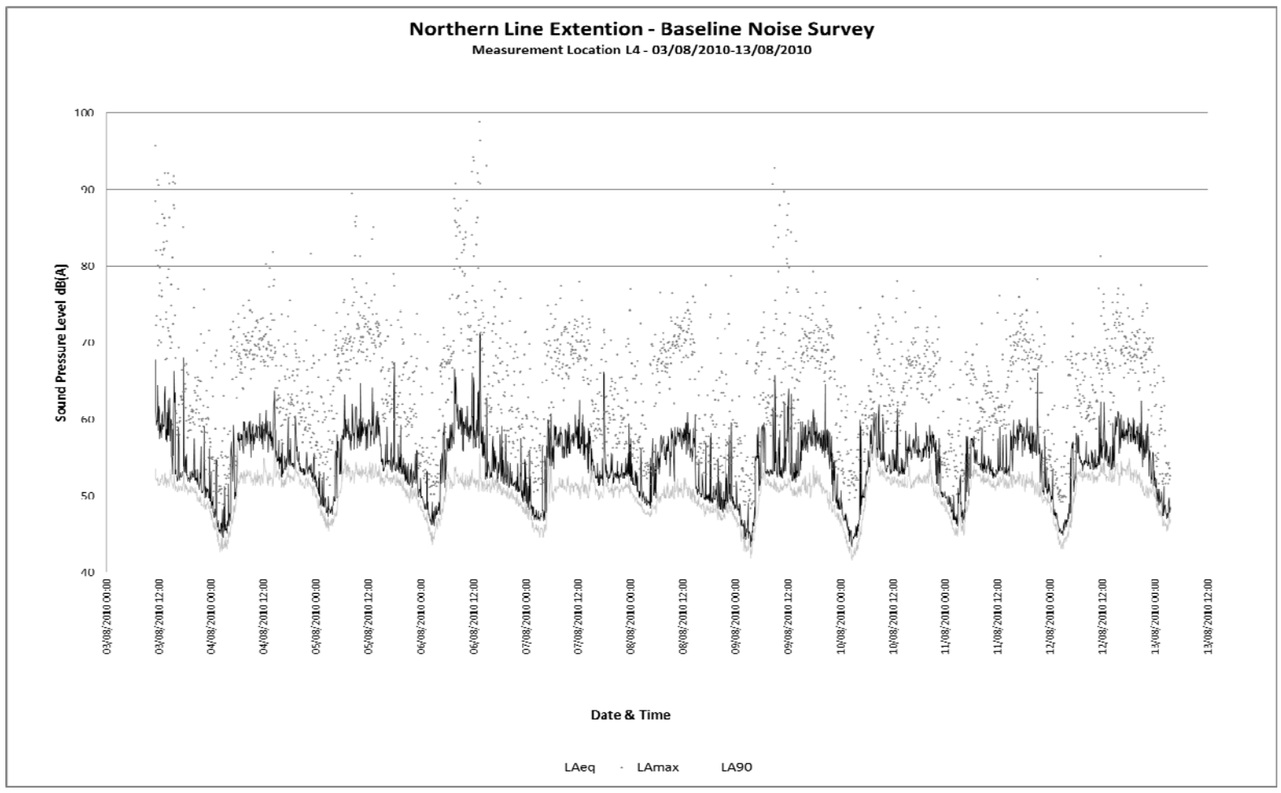

TABLE 32: MEASURED $L_{A90,1h}$ NOISE LEVELS (L4)

Period		$L_{A90,1h}$ Noise Levels (dB)																							
		00:00	01:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
Wednesday	04/08/2010	47	45	44	44	46	48	52	53	53	52	52	52	53	52	54	53	52	52	52	53	52	52	52	51
Thursday	05/08/2010	50	48	47	46	47	50	53	53	53	53	53	53	53	53	53	52	52	52	52	52	51	50	50	49
Friday	06/08/2010	48	47	45	45	47	49	52	52	53	52	52	52	52	52	51	51	51	51	51	50	50	50	49	48
Saturday	07/08/2010	48	47	46	45	46	52	51	51	51	51	51	51	51	51	51	52	50	50	53	51	51	51	51	51
Sunday	08/08/2010	50	50	49	48	48	49	50	50	51	50	51	51	51	51	50	49	49	48	48	48	47	48	48	48
Monday	09/08/2010	47	45	43	43	45	49	53	52	51	51	51	51	52	51	51	51	51	51	52	52	51	50	48	47
Tuesday	10/08/2010	46	44	43	43	44	48	52	56	55	53	53	52	52	52	52	52	52	52	52	52	53	51	50	49
Wednesday	11/08/2010	48	47	45	46	47	50	53	53	52	52	52	51	52	52	51	52	52	52	52	52	51	51	50	50
Thursday	12/08/2010	48	46	44	44	46	49	53	53	53	53	52	53	53	52	52	54	53	53	53	53	52	51	51	51
Weekday Background		48	46	44	45	46	49	52	53	53	52	52	52	52	52	52	52	52	52	52	52	52	51	50	49
Weekend Background		49	48	47	47	47	50	50	51	51	51	51	51	51	51	50	51	50	49	51	50	49	49	50	50

All times refer start time of the hour which they represent

Figure 6: Long-Term Noise Data (Position L5)

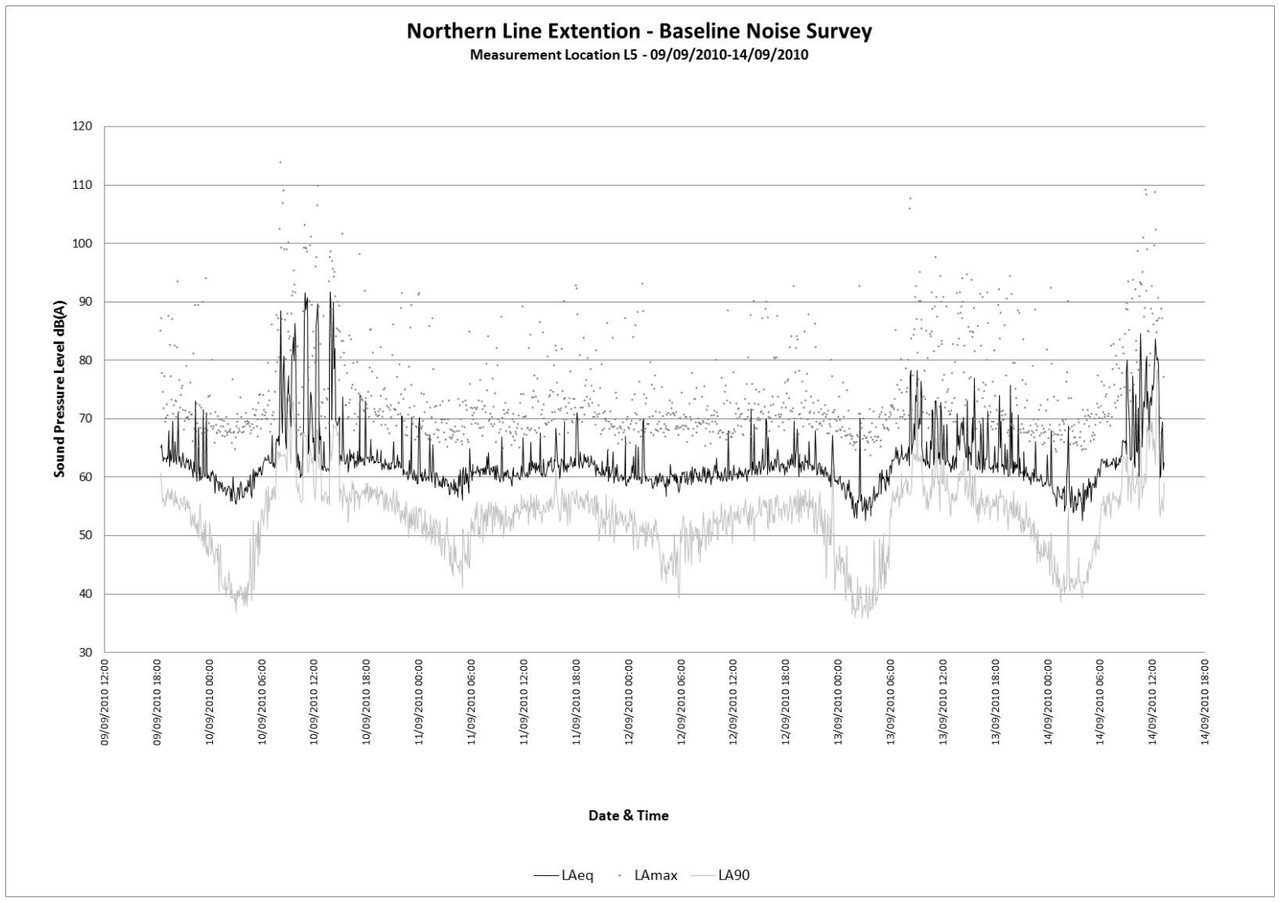

TABLE 33: MEASURED $L_{A90,1h}$ NOISE LEVELS (L5)

Period		$L_{A90,1h}$ Noise Levels (dB)																							
		00:00	01:00	02:00	03:00	04:00	05:00	06:00	07:00	08:00	09:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00
Friday	10/09/2010	48	43	41	40	41	48	55	59	63	70	59	64	62	58	66	56	57	57	57	57	56	55	53	53
Saturday	11/09/2010	52	51	50	48	45	47	52	52	54	53	53	54	55	55	54	57	55	56	56	56	54	53	53	53
Sunday	12/09/2010	52	50	50	49	45	45	50	50	50	51	52	53	53	54	53	55	54	55	55	55	56	54	51	50
Monday	13/09/2010	44	41	39	38	42	46	56	58	60	63	57	61	58	57	60	58	55	55	56	55	54	52	50	47
Weekday Background		46	42	40	39	42	47	56	58	62	66	58	62	60	58	63	57	56	56	57	56	55	54	52	50
Weekend Background		52	50	50	48	45	46	51	51	52	52	52	54	54	54	54	56	55	55	55	56	55	53	52	51

All times refer start time of the hour which they represent

E2: Construction Noise and Vibration Prediction Report

Environmental Statement

Volume II

Construction Noise and Vibration Prediction Report

Northern Line Extension
Environmental Statement
Appendix E2

April 2013

Prepared for:
Transport for London

UNITED KINGDOM & IRELAND

REVISION SCHEDULE					
Rev	**Date**	**Details**	**Prepared by**	**Reviewed by**	**Approved by**
1	April 2013	Final	Simon Perry Principal Consultant	Alf Maneylaws Associate	Paul Shields Head of Acoustics

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Transport for London (TFL)

TABLE OF CONTENTS

1 INTRODUCTION

This appendix of the ES chapter details the work undertaken to determine the impact of construction activities associated with the Northern Line Extension project. The main construction sites will be at the following locations:

- Battersea station;
- Nine Elms station;
- Kennington Green ventilation shaft;
- Kennington Park ventilation shaft;
- Harmsworth Street temporary grouting shaft; and
- Radcot Street temporary grouting shaft.

The noise and vibration impacts from surface construction activities at the above sites have been predicted and compared against the relevant assessment criteria in this appendix.

The impacts of sub surface construction activities such as the tunnel boring works and associated spoil removal are also assessed within this appendix.

Baseline noise measurements have been undertaken at locations representative of the nearest residential receptors to these sites. These measurements are reported in detail in Appendix E1 of this environmental statement.

2 SITE DESCRIPTION

2.1 Battersea Station

The proposed Battersea station site is located within the Battersea Power Station redevelopment area to the south of the Battersea Power Station building. The site is bounded to the west by the over ground train line into London Victoria station, to the east by industrial facilities and to the south by Battersea Park Road. Existing residential properties are located along the southern aspect of Battersea Park Road. The development site is currently vacant.

The Battersea Power Station site and surrounding area have planning permission for redevelopment to form a new mixed use development comprising a mix of commercial and residential buildings. Completion of the early phases of this development will coincide with construction of the station and may include sensitive receptors to noise.

2.2 Nine Elms Station

The proposed Nine Elms station site will be located on land currently occupied by a Sainsbury's supermarket car park, the headquarters building of the Covent Garden Market Authority and an industrial unit owned by Banham Security. The site will be bounded by Sainsbury's supermarket to the north of the site, Wandsworth Road to the east, residential receptors (Pascal Street) to the south and the new Covent Garden Market site and overground

railway into Waterloo station to the north. Existing residential properties are located along the eastern aspect of Wandsworth Road.

2.3 Kennington Green Vent Shaft

The proposed Kennington Green vent shaft head house will be located at the junction between Mountford Place and Kennington Road. The site will be located on the south east corner of an existing industrial site. The specific construction site is vacant land comprising concrete slab.

The vent shaft will be located under a road island at the junction between Kennington Road and Mountford Place. The link between the main shaft and the head house will run in an L configuration east and then south.

2.4 Kennington Park Vent Shaft

The Kennington Park head house will be located in the north east corner of Kennington Park at the junction between Kennington Park and St Agnes Place. The head house will include a traction power sub-station.

2.5 Temporary Grouting Shafts

Temporary grouting shafts are to be excavated at two locations in the Kennington area:

- Harmsworth Street; and
- Radcot Street.

These will both be located on closed sections of the roads in question. Both shafts are located within residential estates in close proximity to dwellings.

3 LEGISLATION, STANDARDS AND GUIDANCE

3.1 British Standard 5228

British Standard 5228 'Noise and Vibration Control on Construction and Open sites' (Ref 1) provides a 'best practice' guide for noise and vibration control, and includes sound power level (L_{wA}) data for plant and activities as well as a calculation method for noise from construction activities.

3.2 Calculation of Road Traffic Noise

Department of Transport (DfT) / Welsh Office Memorandum 'Calculation of Road Traffic Noise (CRTN)' (Ref 2) describes procedures for traffic noise calculation, and is suitable for environmental assessments of schemes where road traffic noise effects occur.

3.3 Design Manual for Road and Bridges

The Highways Agency 'Design Manual for Road and Bridges Volume 11 Section 3 Part 7- Traffic Noise and Vibration' (DMRB) (2011) (Ref 3) provides guidance on the appropriate level of assessment to be used when assessing the noise and vibration effects arising from all road projects, including new construction, improvements and maintenance.

3.4 Control of Pollution Act

The Control of Pollution Act (CoPA) (1974) (Ref4) requires that 'Best Practicable Means' (as defined in Section 72 of CoPA) are adopted to control construction noise on any given site. CoPA makes reference to BS 5228 as best practicable means.

Contained within the CoPA are powers that rest with the local authority under Section 60 to impose requirements on the way construction is carried out, which includes the power to impose noise limits that must be complied with. Section 61 of CoPA allows contractors or promoters to apply for consent to operate construction sites under noise levels set out within the Section 61 application. A Section 61 consent, provided the terms are complied with, prevent a local authority from imposing Section 60 restrictions. The powers under Section 60 and Section 61 apply to surface construction sites and activities only.

3.5 Noise and Vibration Asset Design Guidance

The Transport for London/London Underground Guidance Document G1323 Noise and Vibration Asset Design Guidance (2012) (Ref 5) defines noise and vibration assessment methodologies and criteria that should be used in the design and construction of new operational assets.

3.6 NLE Code of Construction Practice

The Northern Line Extension (NLE) Code of Construction Practice (CoCP), (Appendix O) sets out standards and procedures for managing the environmental impact of constructing the NLE. It covers the environmental aspects of the project (including noise and vibration) that may affect the interests of local residents, businesses, the general public and the surroundings in the vicinity of the proposed construction sites. TfL will take steps to ensure that all parties involved in the construction work (including contractors, sub-contractors and their suppliers) will observe the relevant provisions of the CoCP. The CoCP mandates the use of Section 61 consents for all surface construction works.

4 ASSESSMENT METHODOLOGY AND SIGNIFICANCE CRITERIA

4.1 Construction Noise and Vibration Prediction Methodology

The construction noise and vibration assessment for each of the 6 proposed worksites is based on the type of plant, number of plant, and plant on-time given in Chapter 4 of this ES.

The sound power level and vibration level for each item of plant used in the calculations are taken from BS 5228 Parts 1 and 2.

The prediction methodologies given in BS 5228 Parts 1 and 2 have been used to predict construction noise and vibration due to the above ground works and the Tunnel Boring Machine (TBM).

4.2 Construction Noise Impacts

BS 5228 provides practical information on demolition and construction noise and vibration reduction measures, and promotes a 'Best Practice Means' approach to controlling noise and

vibration. The calculation method provided in BS 5228 is based on the number and types of equipment operating, their associated Sound Power Level (Lw), and the distance to receptors, together with the effects of any screening.

Impact criteria for construction noise have been derived from BS 5228 guidance. The criteria are based on the total noise level due to construction of the railway (pre-existing ambient plus airborne NLE construction noise), measured or predicted at a point one metre in front of the most exposed of any windows and doors in any façade of a building.

The predicted construction noise levels have been assessed using the 'ABC Method' provided in BS 5228, as shown in Table 1.

TABLE 1: CONSTRUCTION NOISE THRESHOLDS

Assessment Category and Threshold Value Period	Threshold Value dB(A)		
	Category A a)	Category B b)	Category Cc)
Night-time (23:00 – 07:00)	45	50	55
Evenings and Weekends d)	55	60	65
Daytime (07:00 – 19:00) and Saturdays (07:00 – 13:00)	65	70	75
NOTE 1: A significant effect has been deemed to occur if the total L_{Aeq} noise level, including construction, exceeds the threshold value for the category appropriate to the ambient noise level. NOTE 2: If the ambient noise level exceeds the threshold values given in the table, then a significant effect is deemed to occur if the total noise level for the period increases by more than 3 dB due to construction activity. NOTE 3: Applies to residential receptors only.			
a) Category A: Threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are less than these values. b) Category B: Threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are the same as Category A values. c) Category C: Threshold values to use when ambient noise levels (when rounded to the nearest 5 dB) are higher than Category A values. d) 19:00 – 23:00 weekdays, 13:00 – 23:00 Saturdays, 07:00 – 23:00 Sundays.			

For the appropriate period the ambient noise level is determined and rounded to the nearest 5 dB. The appropriate Threshold Value is then determined. The total noise level (sum of prevailing ambient level and estimated construction noise level) is then compared with this Threshold Value. If the total noise level exceeds the Threshold Value, then a significant effect is deemed to occur.

4.3 Construction Traffic Noise Prediction Methodology

Construction traffic noise may have an impact on sensitive receptors around the site. The construction traffic impacts have been estimated by considering the changes in traffic flow on the surrounding road network due to the construction of the Proposed Development, following the methodology given in CRTN.

4.4 Construction Traffic Noise Impacts

Construction traffic noise has been assessed by considering the short-term increase in traffic flows during works, following the principles of Calculation of Road Traffic Noise (CRTN) and Design Manual for Roads and Bridges (DMRB).

The criteria for the assessment of traffic noise changes arising from construction works have been taken from Table 3.1 of DMRB and are presented in Table 2.

TABLE 2: ROAD TRAFFIC NOISE ASSESSMENT CRITERIA

Noise Change Band dB(A)	Magnitude of Impact as Given in DMRB	Significance of Effect in Relation to NLE
0	No change	No change
0.1 – 0.9	Negligible	Negligible
1.0 – 2.9	Low	Minor
3.0 – 4.9	Medium	Moderate
5.0 or more	High	Major

4.5 Construction Vibration Impact on Humans

BS 5228 Part 2 provides guidance on the perception of whole body vibration within occupied buildings. This provides a simple method of determining annoyance alongside evaluation of cosmetic damage associated with vibration.

Table 3 details peak particle velocity (ppv) levels and their potential effects on humans, and provides a semantic scale for the description of construction vibration effects on human receptors. This table is adapted from Table B.1 in BS 5228-2:2009.

TABLE 3: BS 5228-2:2009 GUIDANCE ON HUMAN EFFECTS OF VIBRATION LEVELS (PPV)

Vibration Level	Response	Significance of Effect
<0.3 mm/s	Vibration might be just perceptible in the most sensitive situations for most vibration frequencies associated with construction. At lower frequencies, people are less sensitive to vibration.	Negligible
0.3 – 1mm/s	Vibration might be just perceptible in residential environments.	Minor
1 - 10 mm/s	It is likely that vibration of this level in residential environments will cause complaint, but can be tolerated if prior warning and explanation has been given to residents.	Moderate
>10 mm/s	Vibration is likely to be intolerable for any more than a very brief exposure to this level.	Major

The principal concern is generally transient vibration due to piling; however, no piling is expected as part of the construction of the NLE.

4.6 Construction Vibration Impacts on Buildings

Construction activities that generate high levels of vibration may impact on adjacent buildings. Cosmetic damage is most likely to occur within the first 20 metres (m); at greater distances damage is less likely to occur. Likely levels of vibration at given distances can be estimated from existing vibration data, as provided in BS 5228-2:2009.

Further guidance on the vibration impact to structures is given in BS 7385-2:1993, which establishes the basic principles for carrying out vibration measurements and processing the data, with regard to evaluating vibration effects on buildings. Recommended ppv vibration limits for transient excitation for different types of buildings are presented in Table 4. These criteria have been taken from Table 1 of BS 7385-2:1993.

TABLE 4: PEAK PARTICLE VELOCITY LIMITS FOR COSMETIC DAMAGE

Type of Building	Peak Component Particle Velocity [1]	
	Vibration in Frequency Range of 4 Hz to 15 Hz	Vibration in Frequency Range 15 Hz and above
Reinforced or framed structures Industrial and heavy commercial buildings	50 mm/s at 4 Hz and above	
Un-reinforced or light framed structures Residential or light commercial type buildings	15 mm/s at 4 Hz increasing to 20 mm/s at 15 Hz [2]	20 mm/s at 15 Hz increasing to 50 mm/s at 40 Hz and above

1 - Values referred to are at the base of the building. 2 - At frequencies below 4 Hz, a maximum displacement of 0.6 mm (zero to peak) should not be exceeded; mm/s – millimetres per second.

Where the vibration experienced at structures exceeds the values shown above in Table 4 this would be considered to be a significant impact. It should be noted that the criteria used in this assessment relate to the potential for cosmetic damage; structural damage will occur at significantly higher vibration levels. As such the limits in Table 4 are conservative.

5 BASELINE MEASUREMENTS AND ASSESMENT CRITERIA

The full baseline survey results are shown in Appendix E1 of the ES. Table 5 below summarises the measured day and night time baseline levels around the six different construction sites.

TABLE 5: SUMMARY OF BASELINE NOISE LEVELS

Location	Baseline Noise Level L_{Aeq} (dB)		
	Daytime (07:00 – 19:00)	Evenings (19:00 – 23:00) and Weekends	Night (23:00 – 07:00)
Battersea Station *(S1, S2, S3)*[(1)]	72	70	68
Nine Elms Station – *Wandsworth Road (L3, S6)*	59	59	52
Nine Elms Station –*Pascal Street (S4, S5)*	55	53	50
Kennington Green *(L5, S12, S13)*	71	63	61
Kennington Park – *Kennington Park Place (L4)*	58	55	52
Kennington Park – *St Agnes Place (S8)*	61	50	52
Harmsworth Street *(S9)*[(2)]	66	56	56
Radcot Street *(S10)*	56	46	48

Note 1: The evening level has been predicted by correcting the measured daytime noise level assuming the same difference between daytime and evening as recorded at positions L1 and L2.

Note 2: The evening noise level has been assumed to be consistent with the measured night time level. This represents a worst case assumption.

Table 6 below details the criteria for the assessment of construction noise based upon the measured baseline noise levels set out in Table 5. The measured noise levels from Table 5 have been used with the ABC method from BS 5228-1:2009 to define the acceptable construction noise threshold, which is given in Table 6.

TABLE 6: CONSTRUCTION NOISE ASSESSMENT THRESHOLD VALUES

Location	Construction Noise Threshold Values $L_{Aeq\ 10hr}$ (dB)		
	Daytime (07:00 – 19:00) and Saturdays (07:00 – 13:00)	Evenings (19:00 – 23:00) and Weekends	Night (23:00 – 07:00)
Battersea Station *(S1, S2, S3)*	75	73	71
Nine Elms Station – *Wandsworth Road (L3, S6)*	65	65	55
Nine Elms Station –*Pascal Street (S4, S5)*	65	60	55
Kennington Green *(L5, S12, S13)*	75	65	64
Kennington Park – *Kennington Park Place (L4)*	65	60	55
Kennington Park – *St Agnes Place (S8)*	65	55	55
Harmsworth Street *(S9)*	70	60	59
Radcot Street *(S10)*	65	55	55
Battersea Park Phase 1[1]	65	55	45

Note 1: The nearest sensitive receptor is the proposed residential building which forms phase 1 of the Battersea park redevelopment. It is not possible to determine representative ambient noise levels for this position as the proposed building will screen the nearest receptors from the existing ambient noise sources. Therefore for the purpose of this assessment the lower limits set out in table 2 have been assumed.

6 ASSESSMENT AND RESULTS

6.1.1 *Noise modelling*

CadnaA noise mapping software was used to predict construction noise levels at the selected receptors. CadnaA is a sophisticated noise modelling software package that predicts noise levels based on the appropriate input data, such as the location and orientation of equipment and sound power data. The software package takes into account a variety of information about the site including topography and buildings.

The noise model followed the procedures for prediction of construction noise set out in BS 5228-1:2009.

Noise Model Assumptions

The assumptions included in the noise model are presented in Table 7.

TABLE 7: NOISE MODEL ASSUMPTIONS

Model Reference	Time period
Ground Conditions (G)	Ground conditions within the study area comprise hard surfaces such as paving and tarmac. This is a worst case assumption.
Receiver Height	1.5m representative of ground floor windows (this is representative of the worst case predicted levels)
Wind	Light wind (1 to 5m/s) blowing from the source to the receptor
Screening	The models do not include the effects of site hoarding

It is noted that there are a number of uncertainties associated with this modelling due to the assumptions required in the noise model. These uncertainties relate to:

- Assumptions made for the sound power level for each item of construction plant;
- Assumptions relating to the precise number of plant items in use for each model;
- Assumed equipment on-times; and
- Ground conditions surrounding the site which could influence noise levels at receptors.

These uncertainties are considered typical of the level of project design information available in the EIA phase of a project. All technical model assumptions were made using a conservative approach to give a worst-case assessment.

It should also be noted that the prediction of noise from surface construction sites has been undertaken without the inclusion of any specific noise mitigation measures. This is to enable the prediction of a worst-case scenario for all construction sites.

6.2 Station Sites

The station sites will be constructed in the five phases as shown in Table 8.

TABLE 8: STATION CONSTRUCTION PHASES

Phase	Phase
1	Enabling works
2	Tunnel enabling works and station box structure
3	Structural works
4	Building works
5	Fit out, commissioning and handover to LUL

The key noise generating phases will be Phase 1 which will comprise site clearance and Phase 2 which will comprise construction of the diaphragm walls (D-walls) and the excavation of the station box structure in preparation for the tunnel excavation.

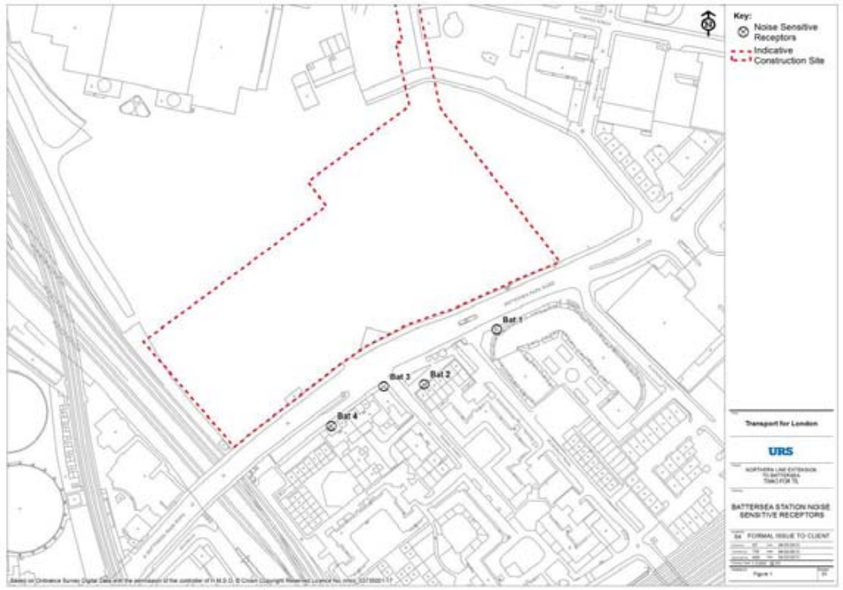
Table 9 below details the different models used to assess the construction activities at each station in the early construction phases:

TABLE 9: STATION SITES CONSTRUCTION NOISE MODELLLING SCENARIOS

Scenario	Phase	Activity	Duration	Assumed Plant
A	Enabling works	Break-out concrete slab	14 weeks	2 no. backhoe mounted hydraulic breakers
B	Tunnel enabling works and station box structure	D-wall construction	9 months – 1 year	2no. Bentonite Plant 2 no. Concrete Mixer/pump 2no. Crawler Crane Concrete Batching Plant 100T Crane
C	Tunnel enabling works and station box structure	Excavation	8 months – 1 year	1 no. Compressor 1 no. Generator 2 no. Excavator 2 no. Dump Truck 2 no. Pumps 3 no. Luffing Jib crane 1no. Conveyor (Battersea only)
D	Tunnel boring	Night time excavated material removal (Battersea only)	1 year	1 no. Excavator 1 no. Conveyor

6.2.1 *Battersea Station*

Figure 1 below details the Battersea station construction area and identifies the nearest sensitive receptors.



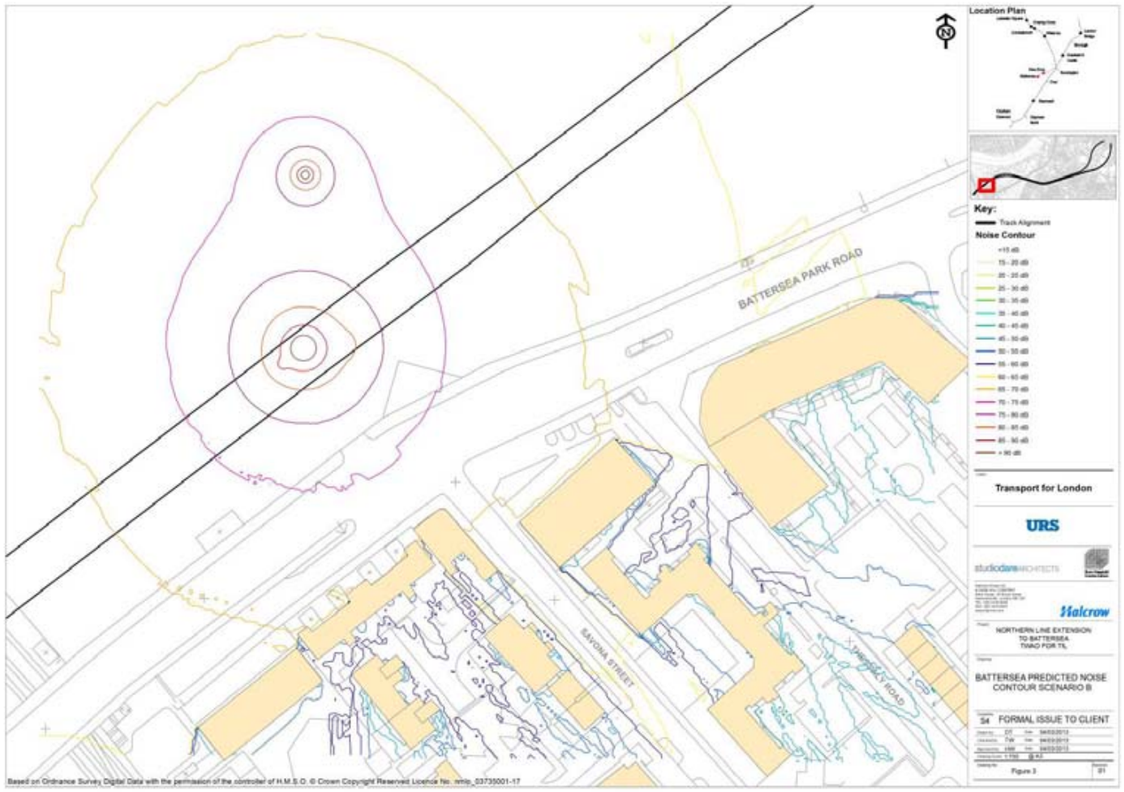
The noise levels at the identified residential receptors have been predicted for each of the four scenarios set out in Table 9. Table 10 below summarises the predicted noise levels.

TABLE 10: PREDICTED CONSTRUCTION NOISE LEVELS BATTERSEA STATION SITE

Receptor	Predicted façade noise level for each scenario $L_{Aeq, 10hr}$ (dB)			
	A	B	C	D
Bat 1 - 75 Battersea Park Road	43	65	60	54
Bat 2 - 85 Battersea Park Road	47	70	64	58
Bat 3 – 101 Battersea Park Road	44	68	63	55
Bat 4 – 101a Battersea Park Road	43	68	64	55

The predicted noise levels reach 70 dB L_{Aeq} during the day and 58 dB L_{Aeq} at night at the nearest residential receptor. This is below the threshold values during the day, evening and nighttime. Therefore, construction activities at this site will not have a significant impact.

Figures 2 to 5 present the predicted noise contours for each scenario. It should be noted that figures 2 and 3 are on a different scale to figures 4 and 5 due to the need to show activities in different areas.


Location Plan
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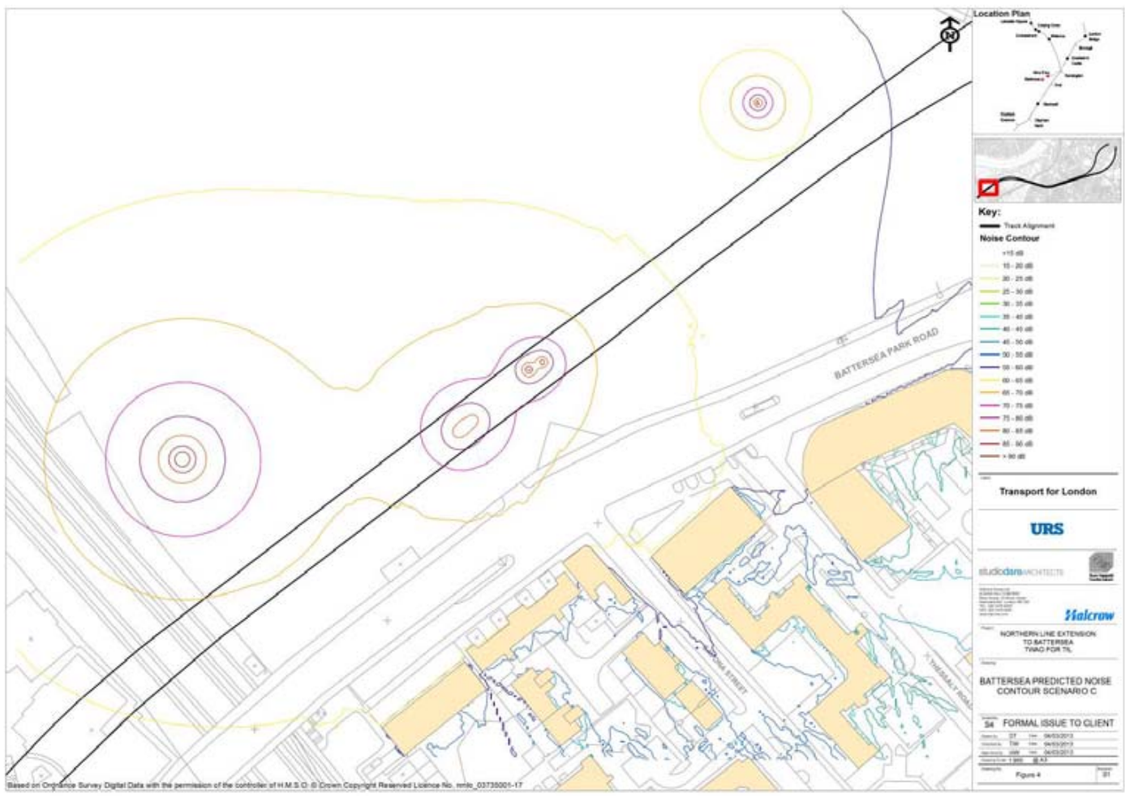
Track Alignment
Noise Contour
BATTERSEA PARK ROAD
Transport for London
URS
Halcrow
NORTHERN LINE EXTENSION TO BATTERSEA TWAO FOR TfL
BATTERSEA PREDICTED NOISE CONTOUR SCENARIO B
FORMAL ISSUE TO CLIENT
Figure 3


Location Plan
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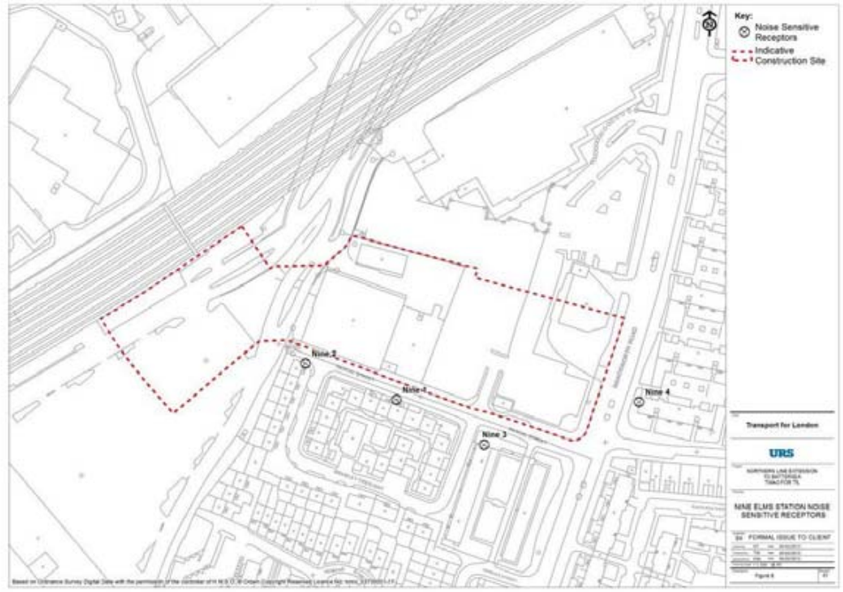
Track Alignment
Noise Contour
BATTERSEA PARK ROAD
Transport for London
URS
Halcrow
NORTHERN LINE EXTENSION TO BATTERSEA TWAO FOR TfL
BATTERSEA PREDICTED NOISE CONTOUR SCENARIO C
FORMAL ISSUE TO CLIENT
Figure 4

6.2.2 ***Nine Elms Station***

Figure 6 below details the Nine Elms station construction area and identifies the nearest sensitive receptors.



The noise levels at the identified residential receptors have been predicted for scenarios A - C in Table 9. No night time excavated material removal is anticipated at this site as such scenario D has not been modelled. Table 11 below summarises the predicted noise levels.

TABLE 11: PREDICTED CONSTRUCTION NOISE LEVELS NINE ELMS STATION SITE

Receptor	Scenario $L_{Aeq, 10hr}$ (dB)		
	A	B	C
Nine 1 – 47 Pascal Street	80	74	74
Nine 2 – 38 Bramley Crescent	76	71	73
Nine 3 - Charman House	78	76	72
Nine 4 - Adrian House	71	71	73

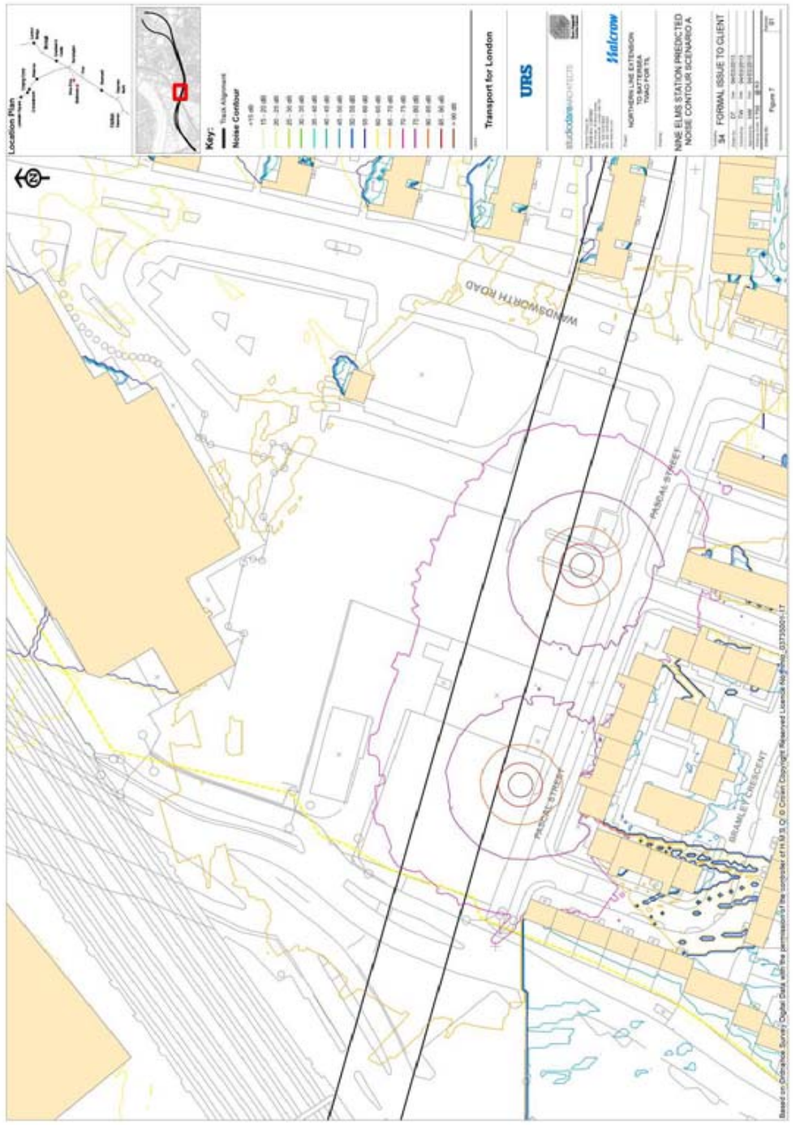
In the table above, it has been assumed that receptors ‘Nine 1’, ‘Nine 2’ and ‘Nine 3’ have the construction noise threshold from Table 6 for ‘Nine Elms Station – Pascal Street’ and receptor ‘Nine 4’ has the construction noise threshold from Table 6 for ‘Nine Elms Station – Wandsworth Road’.

The predicted noise levels from construction activities at Nine Elms station are above the criteria set out in Table 6 and represent a significant effect at all chosen receptors.

However, the predicted noise levels represent the likely worst case during the early phases of construction. In reality this will represent a small proportion, less than 20 %, of the overall construction schedule. It is anticipated that once excavation of the station box has begun the receptors will be shielded from construction noise by the sides of the excavation and therefore the noise levels will reduce to a point where they no longer represent a significant effect.

Figures 7 to 9 on the following pages present the predicted noise contours for each construction activity that has been modelled.

CONSTRUCTION NOISE AND VIBRATION PREDICTION REPORT



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Location Plan
Key:
Track Alignment
Noise Contour
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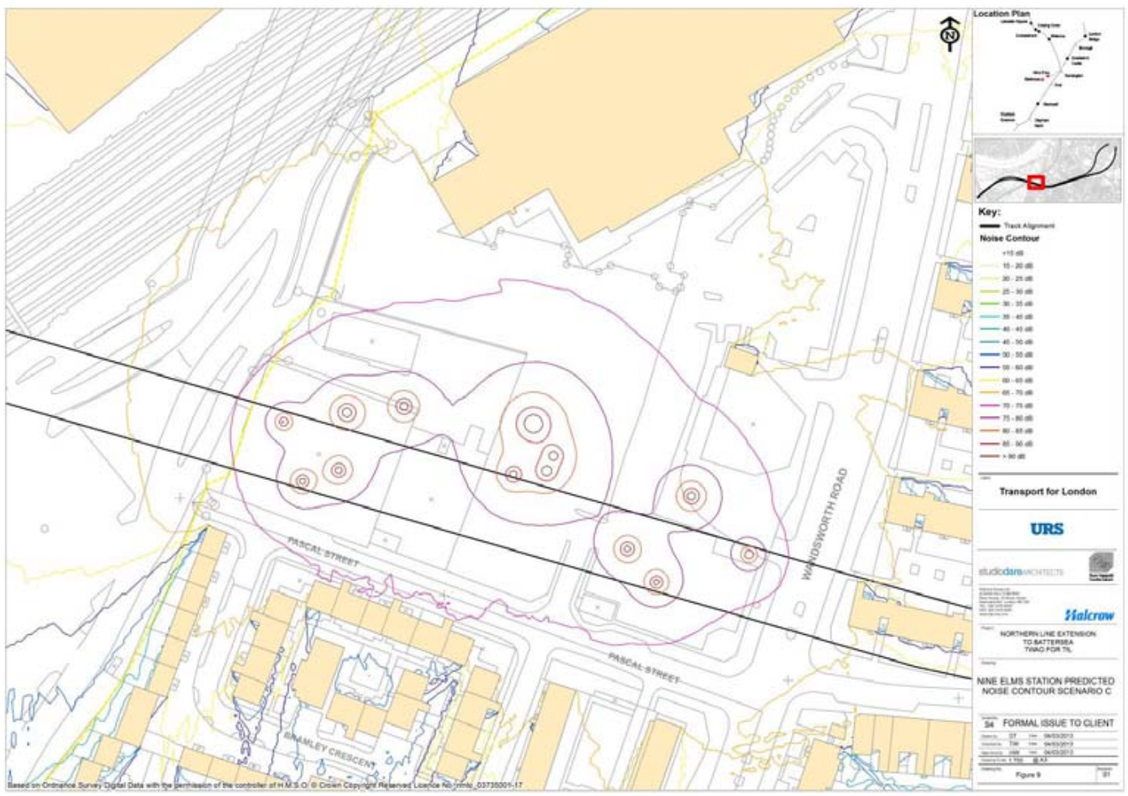
Halcrow
NORTHERN LINE EXTENSION
TO BATTERSEA
TWAO FOR TfL
NINE ELMS STATION PREDICTED
NOISE CONTOUR SCENARIO B
S4 FORMAL ISSUE TO CLIENT
Figure 8
PASCAL STREET
WANDSWORTH ROAD
BRAMLEY CRESCENT


Location Plan
Key:
Track Alignment
Noise Contour
Transport for London
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NORTHERN LINE EXTENSION
TO BATTERSEA
TWAO FOR TfL
NINE ELMS STATION PREDICTED
NOISE CONTOUR SCENARIO C
S4 FORMAL ISSUE TO CLIENT
Figure 9
PASCAL STREET
WANDSWORTH ROAD
BRAMLEY CRESCENT

6.3 Ventilation Shaft Sites

The precise phasing of the ventilation shaft construction programme is not currently known. It is assumed that the key noise generating phase of a shaft construction programme will be the shaft excavation. Table 12 below details the assumed plant during the shaft excavation.

TABLE 12: VENT SHAFT SITE EXCAVATION ASSUMED PLANT

Activity	Duration	Assumed Plant
Shaft excavation	10 weeks	100T Crane
		Batching Plant
		Stand-By Crane
		Main Riding Cage
		Compressor
		Generator
		Excavator
		Dump Truck

6.3.1 *Kennington Green Ventilation Shaft*

Figure 10 below shows the Kennington Green ventilation shaft construction site and identifies the nearest sensitive receptors.

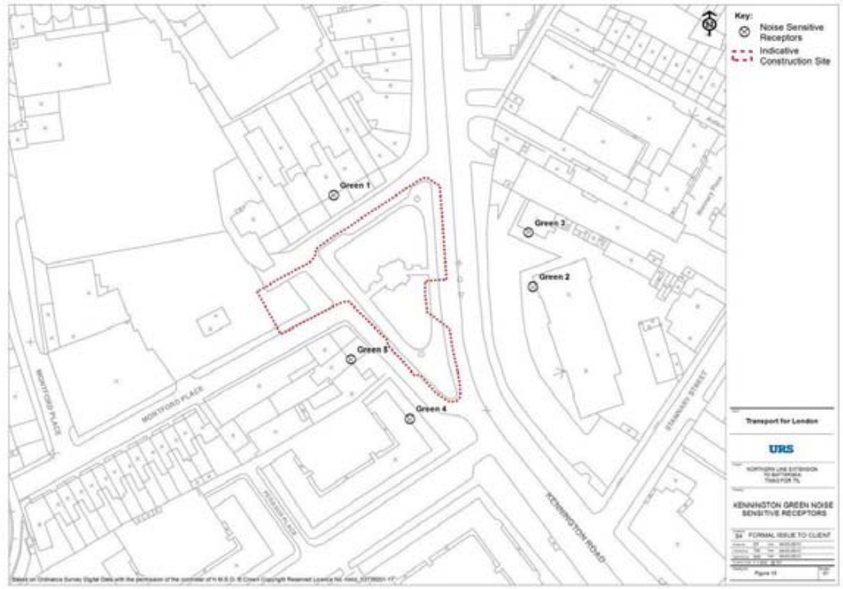


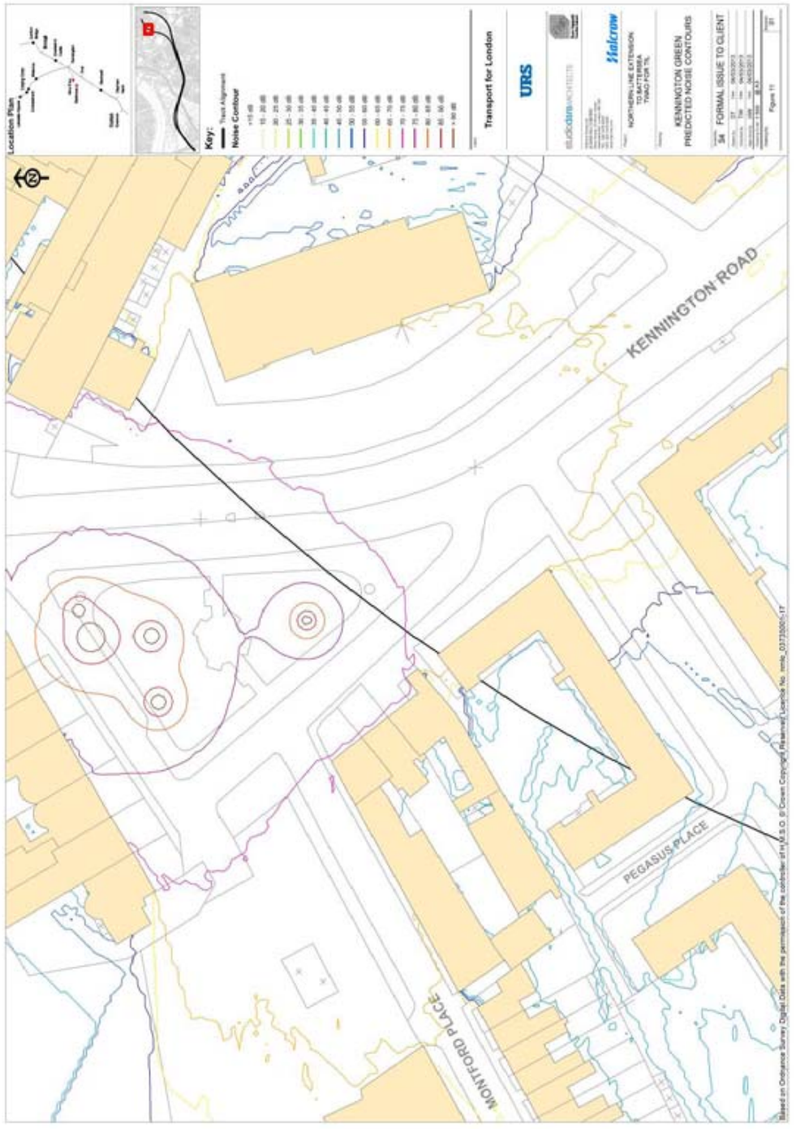
Table 13 below summarises the predicted noise levels for shaft excavation.

TABLE 13: PREDICTED NOISE CONSTRUCTION NOISE LEVEL KENNINGTON GREEN

Receptor	Predicted noise level $L_{Aeq,\ 10hr}$ (dB)
Green 1 – 350 Kennington Road	79
Green 2 – 1 Stannary Street	72
Green 3 - 383 Kennington Road	73
Green 4 – Sherwin House	72
Green 5 – 364 Kennington Road	74

The predicted construction noise levels exceed the threshold limits set out in Table 6 (for Kennington Green) at receptor ‘Green 1’ only. This represents a significant effect at this receptor location. The predicted levels represent the likely most significant noise generating activities which have an anticipated duration of 10 weeks. It is anticipated that construction noise levels will reduce after the completion of shaft excavation.

Figure 11 on the following page presents the predicted noise contours for the construction works that have been modelled.



6.3.2 ***Kennington Park Vent Shaft***

Figure 12 below shows the Kennington Park Vent Shaft construction site and identifies the nearest sensitive receptors.

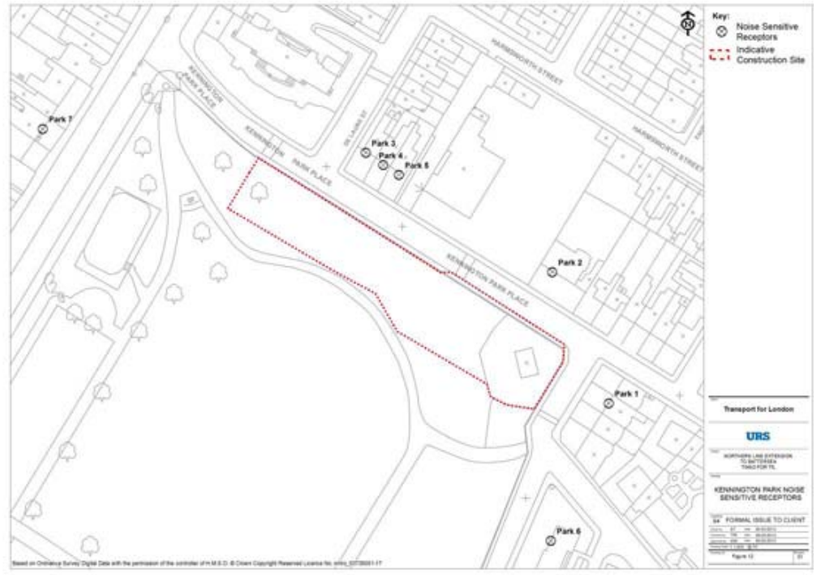


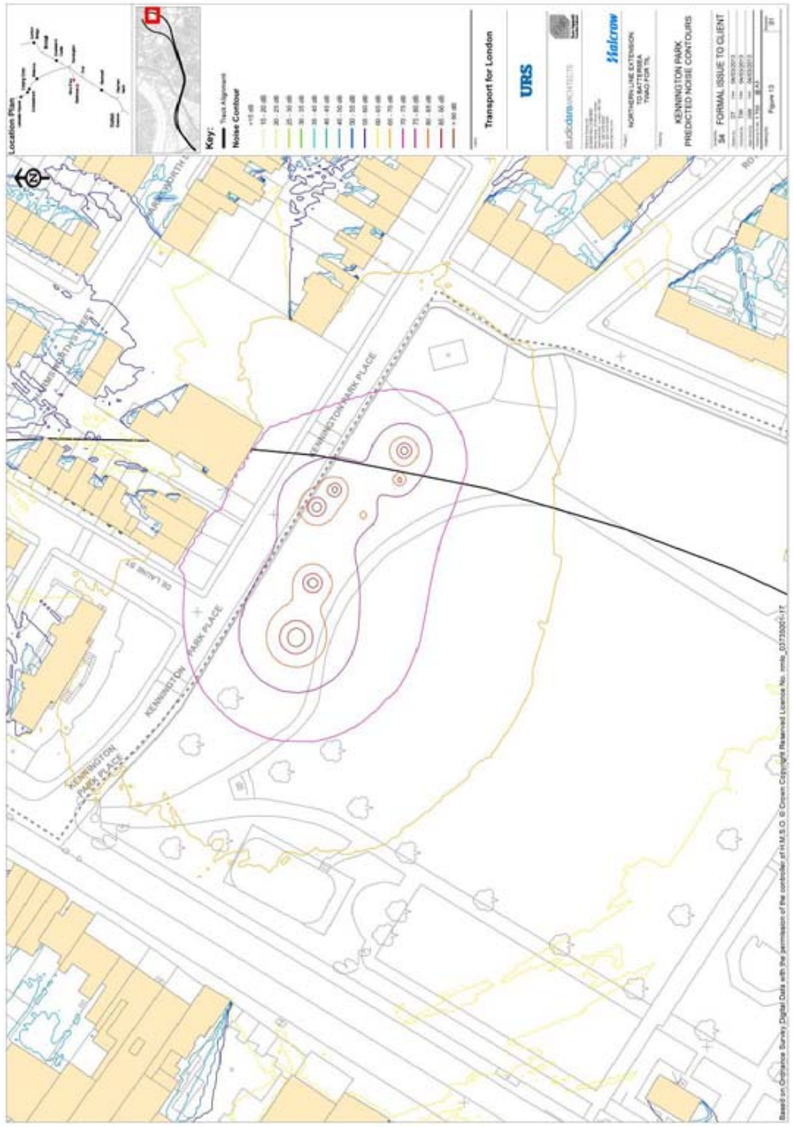
Table 14 below summarises the predicted noise levels for shaft excavation.

TABLE 14: PREDICTED CONSTRUCTION NOISE LEVELS KENNINGTON PARK SITE

Receptor	$L_{Aeq, 10hr}$ (dB)
Park 1 - St Agnes Place	69
Park 2 - 10 Kennington Park Place	70
Park 3 - 1 Kennington Park Place	74
Park 4 - 2 Kennington Park Place	74
Park 5 - 3 Kennington Park Place	77
Park 6 - Conant House, St Agnes Place	68
Park 7 - Kennington Park Road	66

All receptors are assessed against a 65 dB $L_{Aeq,10hr}$ threshold. Predicted noise levels at all receptors are above the noise limits set out in Table 6 (position 1 and 6 are assessed against the limit for St Agnes Place); this represents a significant effect.

Figure 13 presents the predicted noise contours.



6.4 Temporary Shaft Sites

There are two distinct phases when considering the construction noise impact of the temporary shafts:

1. Construction of the shaft and associated site compound; and
2. Undertaking the compensation grouting process.

These phases have been modelled for both temporary shaft sites. The operational grouting has been considered during the day and night time periods.

Enabling works such as concrete breaking have not been considered within this assessment. It is considered that these activities would be very short in duration and not representative of the typical construction activities associated with these sites.

Table 15 below details the construction plant used for the assessment of two different phases of operation:

TABLE 15: STATION SITES CONSTRUCTION NOISE MODELLLING SCENARIOS

Phase	Duration	Assumed Plant
Shaft Excavation	5 weeks	30T Crane Main Riding Cage Compressor Generator Dump Truck Excavator
Grouting works	62 weeks[1]	Compressor Generator

Note 1: Grouting activities will not occur continuously over this period. Grouting activities will only occur when necessary. It is anticipated that this will comprise continuous operation over a number hours.

6.4.1 *Harmsworth Street Temporary Grouting Shaft*

Figure 14 below shows the Harmsworth Street temporary Shaft construction site and identifies the nearest sensitive receptors.

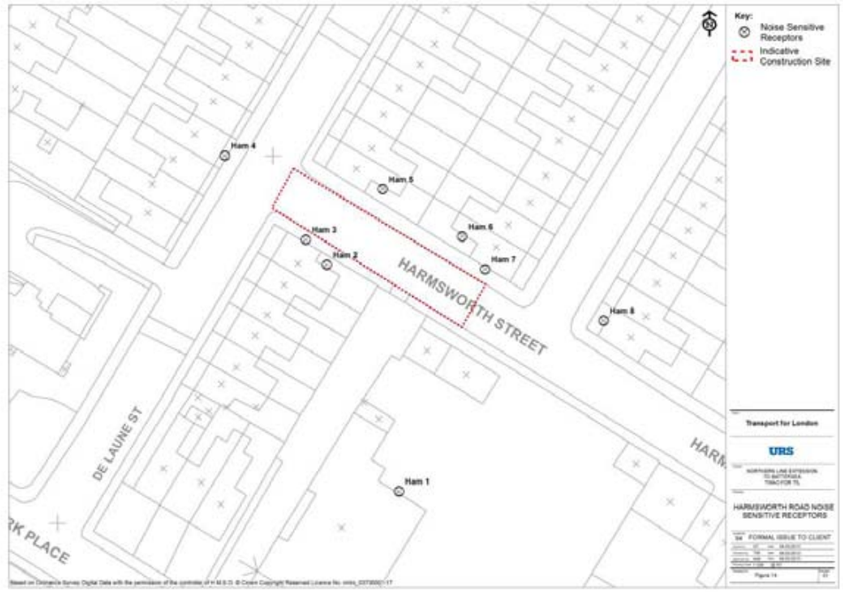


Table 16 below summarises the predicted noise levels.

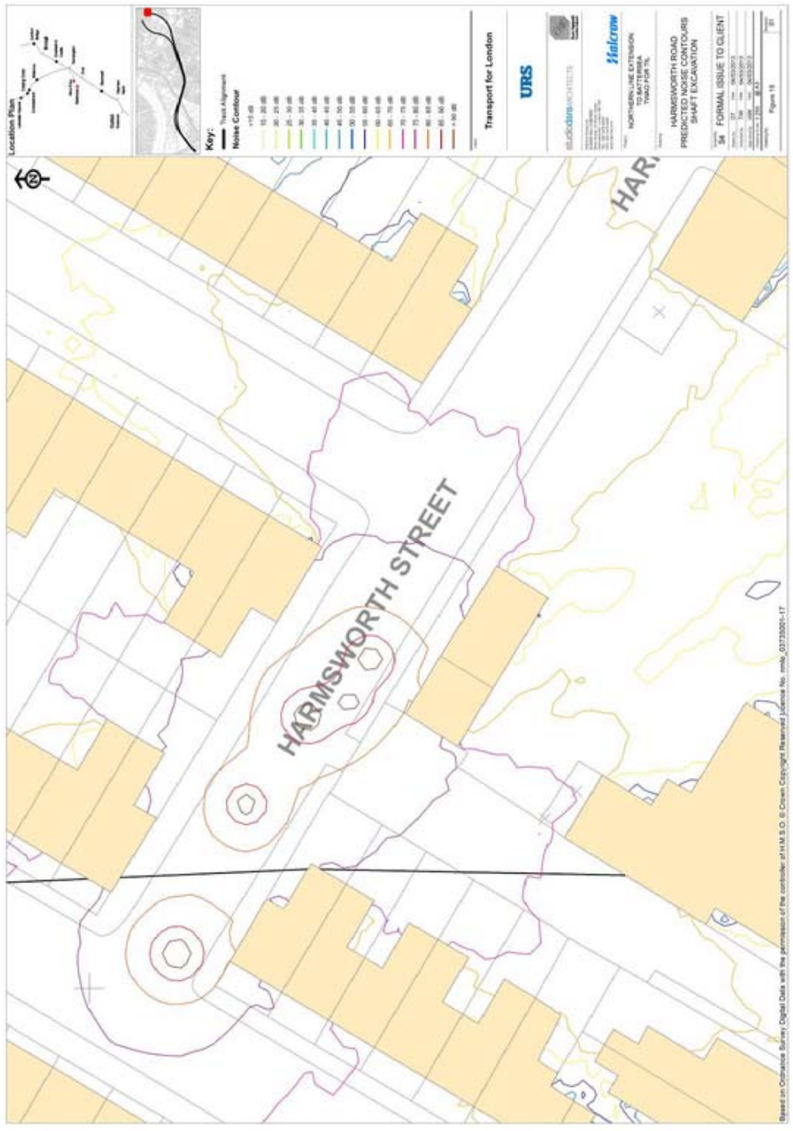
TABLE 16: PREDICTED CONSTRUCTION NOISE LEVELS HARMSWORTH STREET SITE

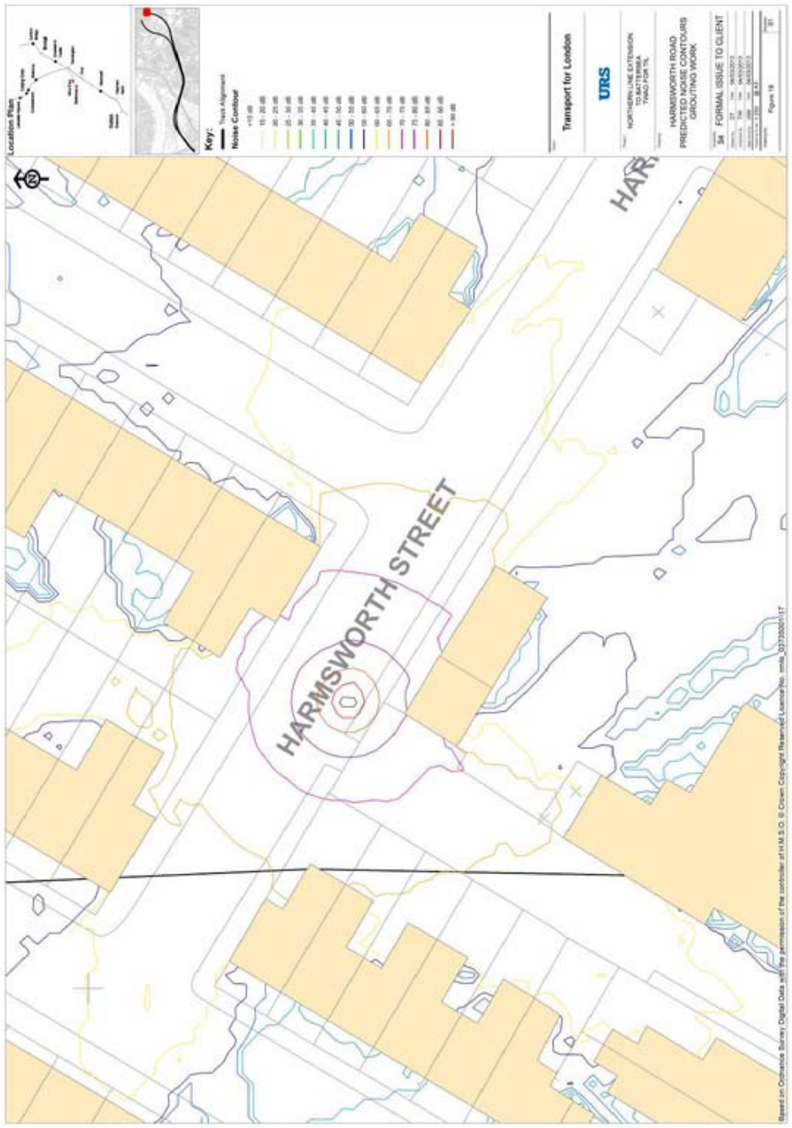
Receptor	Predicted noise level $L_{Aeq, 10hr}$ (dB)	
	Excavation	Grouting works
Har 1 – Bishop's House Nursery	81	69
Har 2 – 90 De Laune Street	83	71
Har 3 – 90 De Laune Street	85	68
Har 4 – 74 De Laune Street	79	66
Har 5 – 1 De Laune Street	82	70
Har 6 – 2 Sharstead Street	83	76
Har 7 – 2 Sharstead Street	81	74
Har 8 – 1 Sharstead Street	74	69

The predicted noise levels from excavation activities at the Harmsworth Street construction site are all above the noise daytime, evening and night time threshold value set out in Table 6. This represents a significant impact at all identified receptors.

It is anticipated that the grouting activities could occur during the evening and night time periods. The predicted noise levels from grouting activities are within the daytime noise limits at locations Har 1, Har 3, Har 4 and Har 8; the remaining locations exceed the daytime limits. The predicted noise level exceed the evening and nighttime threshold values at all receptors this represents a significant impact, however it should be noted that the operation of the grouting plant will be based upon demand and will not be continuous.

Figures 15 and 16 present the predicted noise contours.





6.4.2 *Radcot Street Temporary Shaft*

Figure 17 below shows the Radcot Street temporary shaft construction site and identifies the nearest sensitive receptors.

Table 17 below summarises the predicted noise levels.

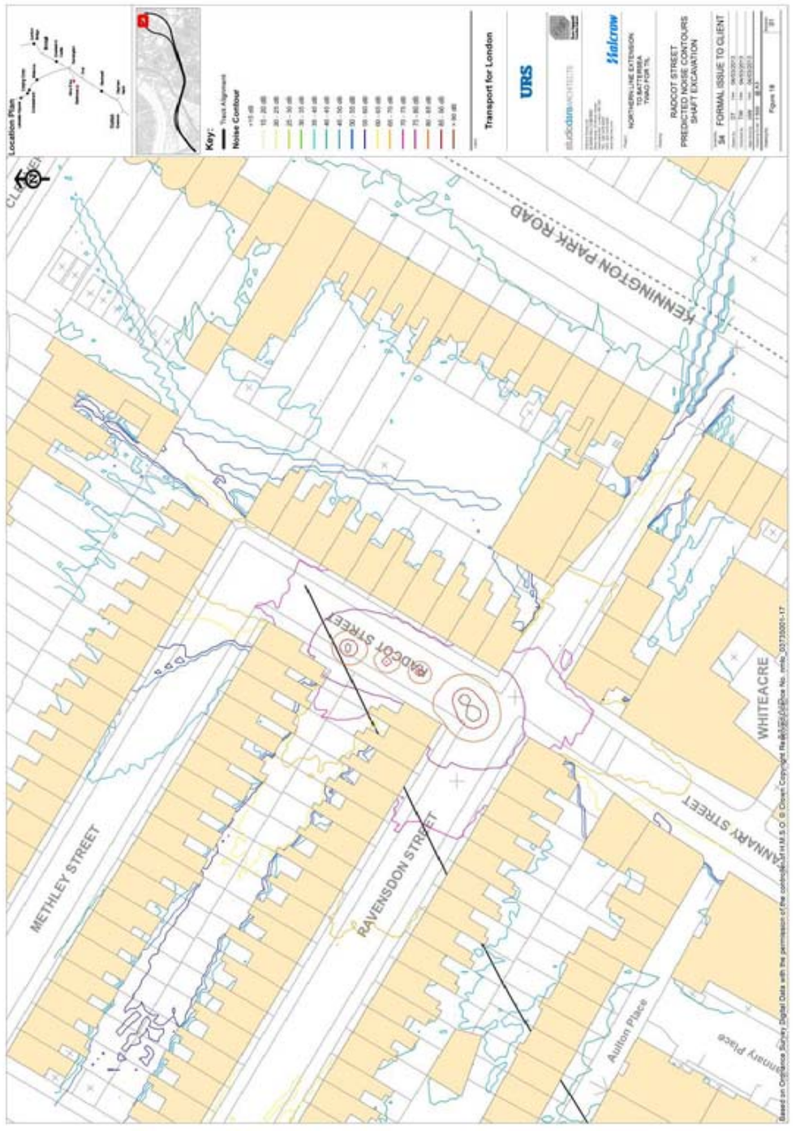
TABLE 17: RADCOT STREET CONSTRUCTION NOISE PREDICTION

Receptor	Predicted noise levels $L_{Aeq, 10hr}$ (dB)	
	Shaft Construction	Grouting operation
Rad 1 - 2 Ravensdon Street	79	73
Rad 2 - 5 Ravensdon Street	81	69
Rad 3 - 1 Methley Street	77	75
Rad 4 - 1 Radcot Street	84	70
Rad 5 - 10 Radcot Street	72	69
Rad 6 - 2 Radcot Street	81	69
Rad 7 - 3 Radcot Street	80	71
Rad 8 - 4 Radcot Street	81	75

TABLE 17: RADCOT STREET CONSTRUCTION NOISE PREDICTION		
Rad 9 - 5 Radcot Street	80	76
Rad 10 - 6 Radcot Street	77	74
Rad 11 - 7 Radcot Street	78	75
Rad 12 - 8 Radcot Street	76	73
Rad 13 - 9 Radcot Street	73	70
Rad 14 - 2 Methley Street	74	69

The predicted construction noise levels for both the construction and grouting phases are above the threshold values for the day evening and night in Table 6 for all receptors. This represents a significant impact at all identified receptors, however it should be noted that the operation of the grouting plant will be based upon demand and will not be continuous.

Figures 18 and 19 present the predicted noise contours for both the shaft excavation and grouting phases.



6.5 Jetty construction

There are two distinct phases when considering the construction noise impact of the jetty at Battersea.

1. Jetty Construction
2. Excavated Material Loading

Table 18 below details the construction plant used for the assessment of these two different phases of operation.

TABLE 18: STATION SITES CONSTRUCTION NOISE MODELLLING SCENARIOS

Phase	Duration	Assumed Plant
Jetty Construction	3 months	Hydraulic Impact Hammer Piling Rig Long Reach Tracked Excavator Dredging Ship
Excavated Material Loading[1]	22 months	Feed Hopper Conveyor Drive Unit 3 Conveyor Drive Units

Note 1: Loading activities will not occur continuously. Loading will only occur when necessary. It is anticipated that this will comprise continuous operation over a number hours.

Table 19 below summarises the predicted noise levels.

TABLE 19: PREDICTED CONSTRUCTION NOISE LEVELS

Receptor	Predicted noise level $L_{Aeq, 10hr}$ (dB)	
	Construction	Loading
Battersea Park Phase 1 North	71	61

The predicted noise levels from construction activities at the jetty site exceed the construction noise threshold values for the daytime period set out in Table 6 during the construction phase of the development but are within for daytime barge loading activities.

It is anticipated that the loading activities could occur during the evening and night time periods. When this occurs the threshold values in Table 6 will be exceeded representing a significant effect.

Figures 20 and 21 present the predicted noise contours.


Location Plan
Key:
Track Alignment
Noise Contour
Transport for London
URS
NORTHERN LINE EXTENSION
TO BATTERSEA
TWAO FOR TfL
BARGE CONSTRUCTION AND
LOADING WORKS
S4 FORMAL ISSUE TO CLIENT
Figure 26
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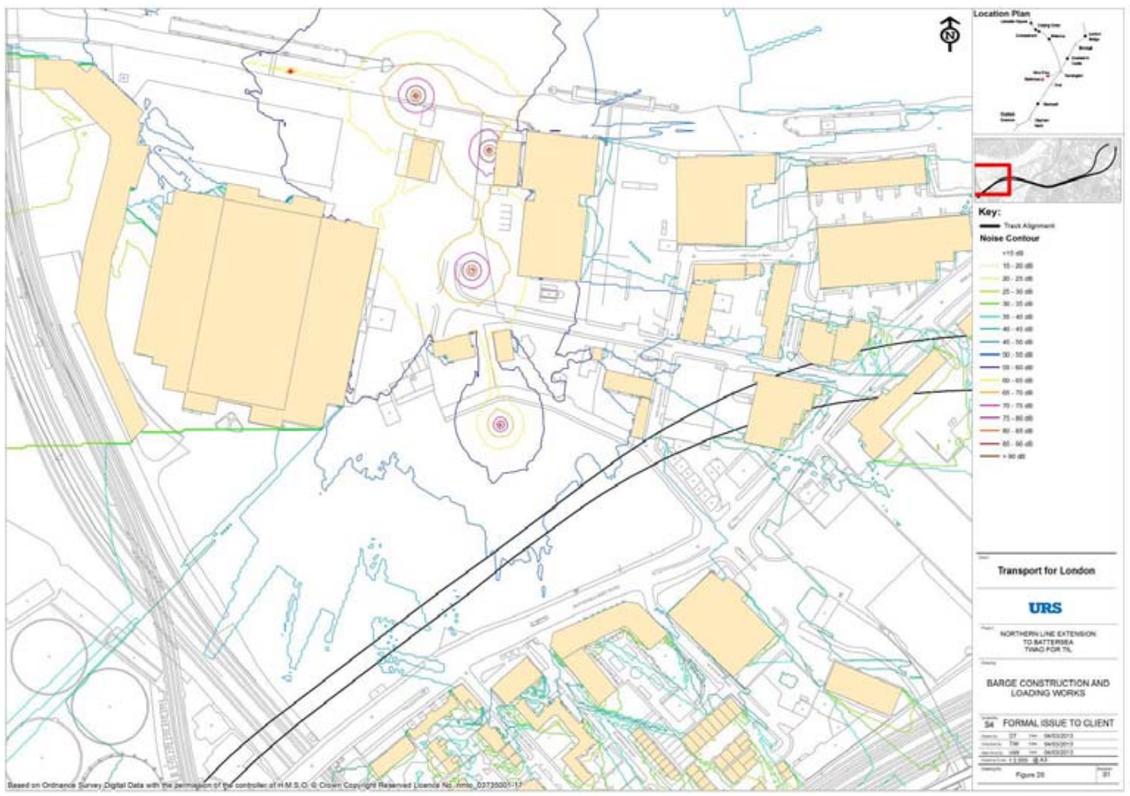
Location Plan
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TWAO FOR TfL
BARGE CONSTRUCTION AND
LOADING WORKS
S4 FORMAL ISSUE TO CLIENT
Figure 26
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6.6 Construction Traffic

Based on information in Chapter 4 of this ES, changes in 18-hour traffic noise levels have been calculated using the methodology provided in CRTN. Baseline traffic flow data have been provided as part of the traffic assessment (as part of Chapter 9: Traffic and Transportation of this ES).

Table 20 presents the construction traffic noise assessment.

TABLE 20: CONSTRUCTION TRAFFIC NOISE ASSESSMENT

Road	Baseline 18-Hour Traffic Flow		Baseline + Construction 18-Hour Traffic Flow		Predicted Change in Traffic Noise Level	Impact Significance
	Total Vehicles	Total HGV (%)	Total Vehicles	Total HGV (%)		
Battersea						
Queenstown Road, north of Prince of Wales Drive	23137	13%	23561	14%	0.4	Negligible
Queens Town road, south of Prince of Wales Drive	23137	13%	23561	14%	0.4	Negligible
Queenstown Road, south of Battersea Park Road	12670	10%	13094	13%	0.7	Negligible
Battersea Park Road, west of Queenstown Road	19951	8%	20375	10%	0.5	Negligible
Battersea Park Road, east of Queens Town Road	28474	10%	28898	11%	0.3	Negligible
Battersea Park road, east of Prince of Wales Drive	28474	10%	28899	11%	0.3	Negligible
Nine Elms						
Wandsworth Road, North of Pascal Street	15519	10%	16502	15%	1.3	Minor
Wandsworth Road, south of Pascal Street	15519	10%	16502	15%	1.3	Minor
Kennington						
Kennington Park Road, south of Camberwell North Road	21584	6%	21790	7%	0.5	Negligible
Kennington Park Road, south of Kennington Road	35677	9%	35883	10%	0.3	Negligible
Kennington Park Road, south of Kennington Park Place	29750	6%	29956	7%	0.4	Negligible
Kennington Park Road, south of Braganza Street	29750	6%	29956	7%	0.4	Negligible
Kennington Road, west of Kennington Park road	21190	7%	21396	8%	0.5	Negligible
Harleyford Road, west of Kennington Park Road	20444	9%	20650	9%	0.5	Negligible
Camberwell North road, east of Kennington Park Road	22026	9%	22231	10%	0.4	Negligible

With reference to the traffic noise assessment criteria in Table 2, it is predicted that construction traffic noise impacts will have a negligible to minor effect at all receptors.

Provision will be made, wherever possible, to ensure that unloading of vehicles will be carried out on-site rather than on the adjacent roads. All construction traffic entering and leaving the Site will be closely controlled. Vehicles making deliveries or removing spoil from the Site will travel via designated traffic routes previously agreed with local authorities and interested parties. Construction traffic will be controlled by means of a vehicle arrival and departure management plan to achieve an even spread of vehicle movements during the working day. Access and egress for construction vehicles may vary according to the particular stage or phase of the works.

6.7 Construction Vibration

BS 5228-2:2009 indicates that construction activities generally only generate vibration impacts when they are located less than 20 m from sensitive locations.

The station structures will be supported by D-walls which also form the retaining structure for the sub ground level aspects of the construction. The highest vibration generating activities are likely to comprise concrete breaking and the construction of the D-walls.

Prediction of the propagation of vibration relating to construction activities is in practice difficult. However, BS 5228-2:2009 provides empirical measurement data for different construction activities (predominantly piling) for different ground conditions and receptor distances. No information is available for the levels of vibration generated by activities

associated with D-wall construction. It is anticipated that vibration caused by construction of the D-walls will be comparable with levels generated through auger piling. Table 21 below details example vibration levels.

The closest residential receptors to the Battersea station and Nine Elms station sites are 15 m and 50 m respectively.

TABLE 21: EXAMPLE AUGER PILING VIBRATION LEVELS

BS5228 Reference No.	Soil Conditions	Plan Distance (m)	PPV (mm/s)
101	Fill / dense ballast / London Clay	20	0.05
		20	0.23
103	Fill clay	20	0.30
		20	0.55
		20	0.44
104	Fill / sand / clay	15	0.10
		14	0.30
		14	0.20
		14	0.80

Based on the example vibration levels in Table 21, and the construction works vibration criteria (Table 3), potential vibration levels from D-walling affecting nearby human receptors (i.e. occupants of adjacent residential dwellings and office units) are considered to be limited to a low magnitude.

With reference to the BS 7385-2:1993 vibration thresholds for cosmetic damage to structures, example vibration levels from auger piling are below the thresholds for cosmetic damage to structures (i.e. on-site structures to be retained, surrounding structures). As such, it is considered that the likelihood of any cosmetic damage to the on-site structures due to vibration from construction activities will be negligible.

6.8 Underground Construction Works (Tunnel Boring Machine)

The railway tunnels between the existing Northern line loop at Kennington station and Battersea Power Station will be constructed using Tunnel Boring Machines (TBMs). This method can give rise to some ground borne noise and vibration that may affect properties above the route alignment.

The prediction of ground borne vibration and noise from TBM excavations has been undertaken using the method provided in BS 5228-2:2009. This provides an empirical calculation of the ground borne noise and vibration given the distance from the tunnel excavations to the assessment location.

The route alignment drawings show that the tunnels will be no shallower than approximately 20 m below ground levels, except on the approach to Battersea station where there are no noise sensitive buildings within 75 m of the tunnel alignment.

The expected ground borne noise and vibration levels from the use of TBMs have been predicted using the empirical methods provided in BS 5228-2:2009. The results of these predictions are provided in Table 22.

TABLE 22: PREDICTED GROUND BORNE NOISE AND VIBRATION LEVELS FROM TBM

Receptor	Predicted PPV, mm/s	Predicted Ground Borne Noise Level, dB L_{Aeq}
Adrian House, Wandsworth Road	0.02	56
Mawbey Brough Health Centre, Wilcox Close, Vauxhall	0.02	55
1 Dorset Road	0.01	52
64 Meadows Road	0.01	50
71 Fentiman Road	0.01	49
17 Carroun Road	0.01	49
24 Claylands Road	0.01	50
Ashmole Primary School	0.01	51
56 Hanover Gardens	0.01	52
Lockwood House, Kennington Oval	0.01	52
Henry Fawcett Junior School	0.01	53
16 Aulton Place	0.02	56
87 De Laune Street	0.02	57

These predictions show that the vibration levels from the use of TBMs are expected to be no more than 0.02 mm/s ppv. When compared with the significance criteria in Table 3 and Table 4, it can be seen that the significance of construction vibration from TBMs is negligible for both the effects on buildings and humans.

The worst-case ground borne noise level for underground tunnelling activities is predicted to be 57 dB L_{Aeq}. This is for a tunnel depth of 20 m. When the tunnels at the lowest point on the alignment are being excavated at approximately 28 m depth, the predicted ground borne noise level drops to 49 dB L_{Aeq}.

However, the data that were employed in the prediction method given in BS 5228-2:2009 were gathered on ground types that are different to the London clay through which most of the NLE tunnels will be constructed. Data have been provided by Crossrail (Ref. 6) from measurements undertaken in properties above the TBM that have been used for that project.

These data are for similar tunnel depths through similar ground type to the NLE, so it is expected that ground borne noise levels are likely to be directly comparable.

The results of the Crossrail measurements show that measured ground borne noise levels are of the order of 35 to 40 dB L_{ASmax} during TBM cutting activities. These results are significantly below those obtained using the method in BS 5228-2:2009 and are expected to be more representative of the levels that will occur from the construction of the NLE tunnels.

The conclusion of the Crossrail report was that ground borne noise from the TBM would be audible inside properties above the line for no more than one day. Based on this, it is expected that the significance of ground borne noise from TBM use during construction of the tunnels will be minor adverse.

7 MITIGATION

7.1 Code of Construction Practice

It will be a contractual requirement on the construction contractors to undertake all works in accordance with the project Code of Construction Practice (CoCP). The code of construction practice includes a series of mitigation and best practice measures that are included to mitigate and reduce construction noise and vibration levels as much as practicable.

For construction carried out at surface sites, such as for stations and ventilation shafts, the following mitigation and best practice measures will be implemented where reasonably practicable and appropriate:

- Each item of plant used on the project will comply with the noise limits quoted in the relevant European Commission Directive 2000/14/EC/United Kingdom Statutory Instrument (SI) 2001/1701 The Noise Emission in the Environment by Equipment for Use Outdoors Regulations (as amended).
- TfL will adopt the recommendations for the control of noise, as set out in BS 5228-1:2009 section 8, and for the control of vibration, as set out in BS 5228-2:2009 section 8. Where alternative authoritative guidance and procedures are thought to be more reasonable and have been agreed in advance with the relevant local authority, these may be adopted in place of the aforementioned.
- Plant and equipment liable to create noise and/or vibration whilst in operation will, as far as reasonably practicable, be located away from sensitive receptors. The use of barriers to absorb and/or deflect noise away from noise sensitive areas will be employed where required and reasonably practicable.
- All plant, equipment, and noise control measures applied, shall be maintained in good and efficient working order and operated such that noise emissions are minimised as far as reasonably practicable. Any plant, equipment, or items fitted with noise control equipment found to be defective will not be operated until repaired.

- Where reasonably practicable, fixed items of construction plant shall be electrically powered in preference to being diesel or petrol driven.
- Vehicles and mechanical plant utilised on site for any activity associated with the construction works will be fitted with effective exhaust silencers and shall be maintained in good working order and operated in a manner such that noise emissions are controlled and limited as far as reasonably practicable.
- Machines in intermittent use will be shut down or throttled down to a minimum during periods when not in use. Static noise-emitting equipment operating continuously will be housed within suitable acoustic enclosure, where appropriate.
- Items of fixed plant such as the air compressors will be located within enclosures and all fresh air and exhaust air systems will be suitably silenced.

The following measures will be adopted for all conveyors:

- The mounting for any conveyors used to remove excavated material from the works (underground, sub-surface or surface) will be designed and installed so as to mitigate the transmission of noise and vibration;
- A maintenance programme will be implemented to ensure that the noise generation of any conveyor does not increase over time.
- The surface conveyor systems will be of similar standard to underground conveyors and will be acoustically enclosed where they run through, or adjacent to, noise sensitive areas. They too will be subject of a maintenance programme. (Note: the conveyer will be covered throughout its length to prevent material spillage.)

For underground activities, the following measures will be adopted, where reasonably practicable and appropriate:

- For the construction railway, the alignment, rail jointing and mounting of the railway will be installed, maintained and operated in a manner so as to minimise the transmission of vibration and ground borne noise from the passage of rail vehicles. Any diesel locomotives used will be fitted with efficient exhaust silencers.
- All tunnel ventilation plant with connections to the atmosphere in any noise-sensitive location will be subject to mitigation measures appropriate to its local environment.

7.2 Section 61 Consents (Surface sites only)

Demolition and construction works will follow Best Practicable Means (BPM) of Section 72 of the Control of Pollution Act 1974 (CoPA) to minimise noise and vibration effects. The demolition and construction programme and activities will be discussed with the relevant local authorities once a contractor has been commissioned. Such details would be set out in Section 61 (CoPA) application(s) submitted by the appointed contractor for consent to conduct

construction activities in advance of their occurrence (a 'prior consent'). It is expected that the Section 61 (CoPA) application(s) will include the following mitigation measures:

- Working Hours: Normal construction hours (e.g. Monday to Friday 08:00 to 18:00 hours, Saturday 08:00 to 13:00 hours, with no working on Sundays or Bank Holidays), except for the following activities:
  - Grouting activities
  - Tunnel boring spoil removal
  - Barge loading
- Access Routes: Routing construction traffic away from Noise Sensitive Receptors (NSRs) where practical.
- Equipment: The use of quieter alternative methods, plant and/or equipment, where reasonably practicable.
- Screening: The use of site hoardings, enclosures, portable screens and/or screening nosier items of plant from NSRs, where reasonably practicable.
- Location: Positioning plant, equipment, site offices, storage areas and worksites away from NSRs, where reasonably practicable.
- Maintenance: Maintaining and operating all vehicles, plant and equipment in an appropriate manner, to ensure that extraneous noise from mechanical vibration, creaking and squeaking is kept to a minimum.

BS 5228-1:2009 indicates that noise attenuation of between 10 and 20 dB may be achieved during the construction phase by selecting the most appropriate plant and equipment and enclosing and/or screening noisier items of plant or equipment.

The appointed contractor will implement suitable mitigation already described, so that significant noise effects are not experienced during the construction of the NLE.

The use of the Section 61 process will ensure, where practicable, that works are carried out on site to meet the target noise levels provided in Table 6: .

There may be exceptional circumstances where it is not practicable to meet the target construction noise thresholds. In such cases, the Northern Line Extension Construction Noise and Vibration Mitigation Scheme (Ref. 7) will provide off-site mitigation to remove residual significant effects that cannot be mitigated through on-site measures. Therefore, the use of the defined mitigation measures will ensure that construction noise will be not significant (negligible to minor adverse).

Therefore, the use of the defined mitigation measures will ensure that construction noise and vibration will not be significant.

8 REFERENCES

Ref. 1 British Standards Institute, (2009); BS5228 - Noise and Vibration Control on Construction and Open Sites, BSi, London.

Ref. 2 Department of Transport/Welsh Office, (1988); Calculation of Road Traffic Noise.

Ref. 3 Highways Agency, (2011); Design Manual for Road and Bridges Volume 11 Section 3 Part 7-Traffic Noise and Vibration.

Ref. 4 Her Majesty's Stationary Office, (1974); Section 72 of the Control of Pollution Act.

Ref. 5 Transport for London, London Underground, (2012) Noise and Vibration Asset Design Guidance Number G1323

Ref. 6 1391_TBM_Monitoring_Draft_Report_0-1_RPS, C300/410 Western Tunnels and Caverns, Tunnel Boring Machine Proactive Groundborne Noise and Vibration Monitoring, February 2013

Ref. 7 London Underground Northern Line Extension Construction Noise and Vibration Mitigation Scheme, Issue 1, November 2012

E3: Ventilation Shaft and Station Noise and Vibration Prediction Report

Environmental Statement

Volume II

Ventilation Shaft and Station Noise Assessment

Northern Line Extension
Environmental Statement
Appendix E3

Final

April 2013

Prepared for:
Transport for London

UNITED KINGDOM & IRELAND

REVISION SCHEDULE					
Rev	**Date**	**Details**	**Prepared by**	**Reviewed by**	**Approved by**
1	April 2013	Final	Anne Elliott Principal Noise and Vibration Consultant	Alf Maneylaws Associate	Paul Shields Head of Acoustics

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SW19 4DR

TABLE OF CONTENTS

1 INTRODUCTION

URS has undertaken baseline noise surveys in the vicinity of proposed ventilation shafts and stations serving the Northern Line extension. The purpose of the surveys was to provide noise data on which to base acoustic design criteria.

This appendix considers the acoustic design criteria for the fans in the ventilation shafts and any other fixed items of mechanical services equipment associated with the new stations and ventilation shafts.

This appendix covers in detail the expected noise emission from ventilation shafts. This is because tunnel ventilation fans are large items of plant and there is the possibility, depending upon the design criteria and measured background noise, that it may not be feasible to design and install a compliant tunnel ventilation system at all locations. Therefore, to provide assurance of it being possible to meet the required design criteria, the feasibility of providing a compliant design has been investigated in detail.

It has been assumed that all other items of plant and equipment, such as air conditioning condensers and small ventilation fans are easily mitigated at the detailed design stage and do not require detailed assessment at this stage. It should also be noted that small items of plant and equipment have not been designed in sufficient detail to allow a full and detailed assessment of the noise effects of these smaller items of equipment. However, the design criteria contained within this appendix are valid for all items of fixed plant and equipment and will be used at the detailed design stage to ensure compliance with the environmental noise requirements.

2 REPORT TERMINOLOGY

For the purposes of this report, the following terminology and abbreviations are used:

- dB(A) – The unit of noise measurement that expresses the noise in terms of decibels (dB) based on a weighting factor for humans sensitivity to sound (A);
- Hz – Hertz;
- L_{A90} – A-weighted sound pressure level exceeded for 90% of the measurement time;
- L_{Aeq} – Equivalent continuous A-weighted sound pressure level over a given period of time;
- L_w – Sound Power Level; and
- L_p – Sound Pressure Level.

3 VENTILATION SHAFT AND STATION LOCATIONS

There is one ventilation shaft located at Kennington Green and one at Kennington Park. There are also ventilation shafts at the Nine Elms station and the Battersea station.

For Kennington Green and Kennington Park, the shaft will terminate within ground level headhouses with a louvred opening. At Nine Elms station the shafts will either terminate at louvred openings in the station facades or will be constructed through the station building to

terminate at roof level. At Battersea station the shafts will either terminate at louvred openings in the facade of a new building to be constructed as part of the re-development of Battersea Power Station, or will be constructed through this building to terminate at roof level.

4 FAN OPERATION

It is understood the tunnel ventilation fans in the ventilation shafts will not be in use during normal day to day operation of the line. These fans will only be used during periods when trains are stationary within the tunnels for a prolonged period of time as a result of breakdowns or emergencies. As such, operation of the tunnel ventilation fans is only expected on an occasional basis and would rarely if ever occur during the night time. Smaller capacity Under Platform Exhaust (UPE) fans located at the stations will be operated seasonally.

It is understood there will be a traction power sub-station located at the Kennington Park headhouse. There is likely to be other plant associated with the shafts and stations but no details are available at this time.

5 RELEVANT STANDARDS AND GUIDANCE

5.1 BS4142

BS 4142: 1997, 'Method for rating industrial noise affecting mixed residential and industrial areas' (Ref. 1) is commonly used for the assessment of fixed plant, such as transformer rectifiers, cooling units etc.

The basis of the standard is a comparison between the background noise level in the vicinity of residential locations and the rating level of the noise source under consideration. The relevant parameters in this instance are as follows:

- Background Noise Level - $L_{A90,T}$ - defined in the Standard as 'the 'A' weighted sound pressure level at the assessment position without the industrial source operating which is exceeded for 90 % of the given time interval, T, measured using time weighting F (fast);
- Specific Noise Level - $L_{Aeq,T}$ - the equivalent continuous 'A' weighted sound pressure level of the source in question over a given time interval; and
- Rating Level - $L_{Aeq,T}$ - the Specific Noise Level plus any adjustment made for the characteristic features of the noise.
- A correction of +5 dB is made to the Specific Noise Level if one or more of the features noted below is present. (Only one +5 dB correction is made regardless of the specific noise level containing one or more of the following characteristics).
  - the noise contains a distinguishable, discrete, continuous note (whine, hiss, screech, hum, etc.);
  - the noise contains distinct impulses (bangs, clatters or thumps); or
  - the noise is irregular enough to attract attention.

Once any adjustments have been made, the background noise level is subtracted from the rating levels. The standard states that the greater this difference, the greater is the likelihood of complaints;

- a difference of around +10 dB or more (rating level minus background noise level) indicates that complaints are likely;
- a difference of around +5 dB is of marginal significance; and
- if the rating level is more than 10 dB below the measured background level, this is a positive indication that complaints are unlikely.

The standard specifies a one hour assessment period during the day and a five minute period at night. All noise levels are assessed as 'free-field' levels unless it is necessary to carry out an assessment above ground floor level, in which case measurements are made 1m from the façade of the relevant building.

5.2 LUL Design Guidance

LUL Guidance Document G1323 (Ref. 2) defines noise and vibration assessment methodologies and criteria that should be used in the design of operational assets[1]. It states that:

3.2.2 Under the National Planning Policy Framework March 2012, new developments should look to conserve and enhance the natural environment. Noise assessments for the majority of fixed installations (excluding public address systems and audible warning systems) should therefore be based on the method described in BS4142:1997 which assesses the impact of fixed developments on the local noise environment.

3.2.3 The assessment method in BS4142:1997 requires the airborne noise arising from a fixed installation to be predicted (expressed in terms of the rating level) and subtracts it from the existing background noise (expressed in terms of the $L_{A90,T}$ noise level). The rating level takes account of tonal or impulsive characteristics of mechanical and electrical services plant.

3.2.3 The noise from the fixed installations in normal operation would not be considered to be significant if the difference between the predicted rating level (as determined for the worst affected residential dwelling) and the existing background noise level is not more than +5 dB, assessed in accordance with BS 4142:1997. The assessment should be carried out for day and night time periods as described in BS 4142:1997 and as appropriate for the fixed installations. The criterion must be met for both periods.

3.2.4 The criterion should be applied to the combined noise of all new or upgraded fixed installations (except public address and audible warning systems) at a single development site.

3.2.5 In recognition that local authorities' preference is for the rating levels of fixed installations to be no greater than $L_{A90,T}$-10, the designers should use reasonable endeavours to meet this requirement where it is practical and feasible.

[1] It should be noted the LUL Design Guidance is quoted as per the published document which erroneously includes two paragraphs numbered 3.2.3. In addition the first paragraph 3.2.3 incorrectly states the rating level is subtracted from the background level whereas the background level should in fact be subtracted from the rating level.

5.3 London Borough of Wandsworth

The London Borough of Wandsworth requirement is for the Rating Noise Level due to plant not to exceed a level 10 dB(A) below the minimum L_{A90} noise level during the time the plant is operational. Noise emissions should be assessed according to the method described in BS4142:1997.

5.4 London Borough of Lambeth

The London Borough of Lambeth requirement is for "*Noise arising from the use of the condenser, air conditioning units and associated equipment and any other plant equipment shall not increase the existing background noise level ($L_{A90\ 5mins}$) when measured ($L_{Aeq\ 5mins}$)1 metre external to the nearest noise sensitive premise or residential property. The fan and associated duct work, should be silenced, and isolated from the building structure, in accordance with a scheme submitted to, and approved by the Local Planning Authority*".

6 NOISE SURVEY

Long term and short term noise monitoring was undertaken at the proposed locations for each ventilation shaft and station. Full details of the survey locations, methodology and results are contained in Appendix E1.

7 PROPOSED NOISE LIMIT AND DESIGN CRITERIA

The assessment of significance of noise from fixed plant and equipment is based on the procedure outlined in BS 4142:1997. The significance criteria used in the ES are provided in the Table 1 below. These have been based on the guidance provided in BS 4142:1997.

TABLE 1: SIGNIFICANCE CRITERIA FOR FIXED PLANT AND EQUIPMENT

Rating Level minus Background Level	Significance of Effect
Rating noise is 5 dB(A) or more below background level	Negligible
Rating Level is between 5 dB(A) below and 5 dB(A) above background	Minor Adverse
Rating Level is between 5 dB(A) and 10 dB(A) above background	Moderate Adverse
Rating noise is more than 10 dB(A) above the background level	Major Adverse

The design criterion that will be adopted for the tunnel ventilation fans is such that the Rating Level does not exceed a level 5 dB(A) below the prevailing L_{A90}. A design target of 5 dB below the background has been chosen since the majority of the large items of plant, such as tunnel ventilation fans, will only be used infrequently. The fans are provided to ensure that there is airflow in the event of trains stopped in the tunnels between stations. This will only happen when the Northern line is operating with a disrupted service and should not happen when the Northern line is running a good service.

As such, the tunnel ventilation fans will only operate during normal operating hours when there is disruption to service and it is very unlikely that they will operate during the nighttime. Since this method of operation is expected to be infrequent, a design target of 5 dB below

background has been used to allow for the infrequent nature of the operation of this noise source.

8 NOISE SENSITIVE RECEPTORS

Table 2 identifies the noise sensitive receptors which should be taken into consideration when assessing noise from the fixed plant installations. The locations of the receptors are identified in the baseline noise survey report in Appendix E1.

TABLE 2: NOISE SENSITIVE RECEPTORS

Location	Receptor
Kennington Park	Residences on St Agnes Place Residences on Kennington Park Place
Kennington Green	Residences on Kennington Road
Nine Elms	Residences on Bramley Crescent Residences on Pascal Street Charman House Adrian House
Battersea	New residential properties in the Battersea Power Station development

9 FEASIBILITY ASSESSMENT

The feasibility of achieving the proposed design criteria has been assessed by considering the noise level required at the worst affected receptor for each ventilation shaft location. The design target at each of these locations is derived based on the measured background noise for each location. The assessment is made using the nighttime background noise levels, which will give a worst-case assessment. The target noise level is then used with the approximate distance to the nearest noise sensitive receptor to calculate the limiting sound power level at the ventilation grille/louvre. Table 3 presents the calculation of the limiting sound power level based on the typical lowest night time $L_{A90,1hr}$, as defined by the Crossrail method for determination of the background (Ref. 3), and the proposed design criterion.

TABLE 3: CALCULATION OF LIMITING FAN SOUND POWER LEVEL

	Kennington Park	Kennington Green	Nine Elms	Battersea
Typical lowest night time $L_{A90\ (1hr)}$ (dB)	44	39	45	43
Proposed design criteria 5dB below L_{A90} (dB)	39	34	40	38
Distance of louvre to nearest residence (m)	25	25	12	5
Distance correction (dB(A))	28	28	22	14
SPL to SWL (dB(A))	8	8	8	8
Limiting SWL at louvre (dB(A))	80	75	75	65

The operating conditions provided in Table 3 do not cover situations such as emergency situations (e.g. fire), which are excluded from assessment in an Environmental Statement.

The calculated sound power levels have been confirmed as achievable by the M&E consultants (Halcrow) as set out in Technical note Reference GRNLEB-HGL-00-XX-TNT-FIR-00065. Table 4 below summarises the calculated limiting sound power levels and the anticipated worst case tunnel ventilation fan sound power levels during normal operation.

TABLE 4: CALCULATED AND PROPOSED FAN SOUND POWER LEVEL

Vent Location		Octave Band Centre Frequency (Hz)								dBA
		63	125	250	500	1k	2k	4k	8k	
Kennington Park	Limiting L_w	97	87	80	74	71	70	70	72	**80**
	Proposed L_w	75	71	60	47	44	40	31	30	**58**
Kennington Green	Limiting L_w	92	82	75	69	66	65	65	67	**75**
	Proposed L_w	75	71	60	47	44	40	31	30	**58**
Nine Elms	Limiting L_w	92	82	75	69	66	65	65	67	**75**
	Proposed L_w	73	71	60	44	40	35	26	25	**57**
Battersea	Limiting L_w	82	72	65	59	56	55	55	57	**65**
	Proposed L_w	73	71	60	44	40	35	26	25	**57**

The results presented in the Table 4 show that for all ventilation shafts, the calculated sound power levels from the tunnel vent fans are below the design target sound power levels. The tunnel vent systems designed by Halcrow are expected to meet the design target of 5 dB below the background noise for all locations. Therefore, it is expected that the significance of operational noise from fixed plant and equipment will be negligible.

As noted in Section 1 above, there will be other items of mechanical services equipment located at the new stations and there will also be noise from the use of PA systems. These systems will also be designed to meet the proposed design criterion and therefore when installed will meet the proposed noise limit. This will be achieved through the use of good design practices, the use of suitable attenuators and acoustic screens as necessary and the location of plant and equipment in enclosures and plantrooms as necessary.

It is considered the cumulative noise levels due to all mechanical services equipment and activities at both stations will meet the proposed noise limits. This is considered due to the adoption of a design criteria based on the typical lowest night time background noise level whereas most noise producing activities will only occur during the daytime. In addition, the ventilation shaft fans will only be used occasionally, as will the PA system. There is also further scope for the introduction of additional noise mitigation measures should they be necessary.

In all cases it is expected that the proposed noise limit will be achieved and the significance of the effect is predicted to be negligible.

10 CONCLUSION

Baseline noise surveys have been undertaken along the route of the proposed Northern Line extension at the location of proposed ventilation shafts and stations where mechanical services equipment will be installed.

Noise limits and acoustic design criteria have been proposed based on a range of standards and guidance documents and also the likely operation of the ventilation shaft fans.

Noise limits are proposed at 5 dB(A) below the existing background L_{A90} noise level.

A feasibility assessment has concluded the proposed noise limits would be achievable by the fans serving the ventilation shafts.

Mitigation measures will also be introduced as necessary in the design of other mechanical services equipment serving the stations and to the PA systems at the stations.

11 REFERENCES

Ref. 1 British Standards Institution (1997): BS 4142 Method for rating industrial noise affecting mixed residential and industrial areas, BSi, London

Ref. 2 London underground, (2012): G1323 Noise and Vibration Asset Design Guidance, Transport for London

Ref. 3 CRL1-XRL-T1-GPD-CRG03-50002 Method for Establishing Background Noise Levels for Fixed Installation Assessments, Rev 0, 04/05/12

E4: Groundborne Noise and Vibration Prediction Report

Environmental Statement

Volume II

Groundborne Noise and Vibration Prediction Report

Northern Line Extension
Environmental Statement
Appendix E4

April 2013

Prepared for:
Transport for London

UNITED KINGDOM & IRELAND

REVISION SCHEDULE					
Rev	**Date**	**Details**	**Prepared by**	**Reviewed by**	**Approved by**
1	April 2013	Final	Steve Cawser Senior Noise and Vibration Consultant	Alf Maneylaws Principal Noise and Vibration Consultant	Paul Shields Technical Director Acoustics and Vibration

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TABLE OF CONTENTS

1 INTRODUCTION

This Appendix outlines in detail the methodology that has been used in the prediction of the groundborne noise and vibration levels from the Northern Line Extension (NLE) and presents the predicted groundborne noise and vibration levels.

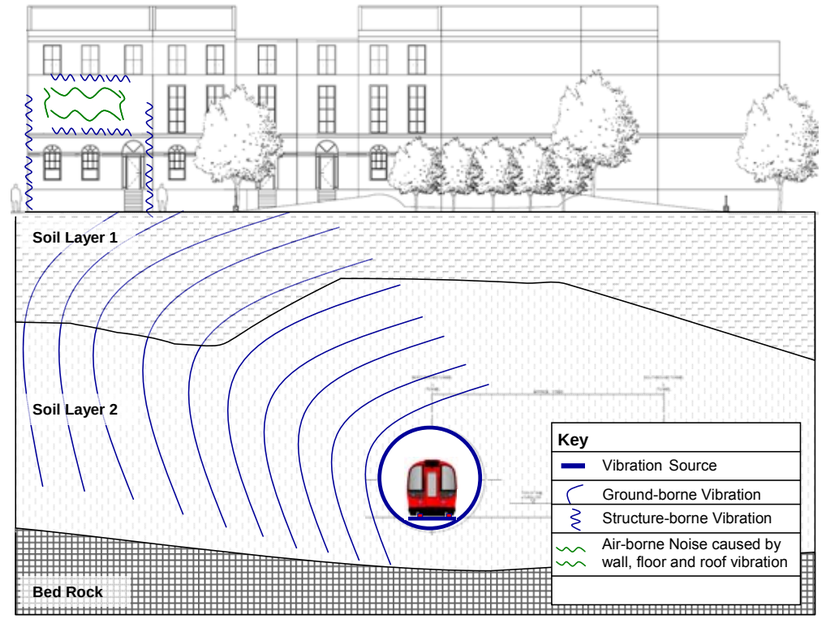
2 GROUNDBORNE NOISE AND VIBRATION

Underground rail traffic has the potential to generate groundborne noise within properties above the line. Vibration is generated by trains due to the interaction between the roughness of the running surfaces of the wheels of the trains and the rail of the track. This roughness, the amplitude of which is typically less than a millimetre, generates a fluctuating force at the contact patch between the wheels and rails. This force generates vibration that propagates into the rails and vehicle wheels, where it is radiated as airborne noise; and also propagates into the ground.

The vibration is of sufficient amplitude that it can propagate into buildings above the railway tunnel. When it enters such structures, it can be perceived as feelable vibration, but more commonly, it causes the structural elements of the building to vibrate and radiate sound into rooms within the building. This audible sound is known as groundborne noise.

This vibration phenomenon is illustrated in Figure 1.

FIGURE 1: VIBRATION AND NOISE DUE TO UNDERGROUND TRAINS



Groundborne noise is a particular problem for underground railways. When a building is located next to a surface railway, any noise will be heard as a combination of the airborne noise and groundborne noise combined. As such, the significance of the groundborne noise for surface railways is low since the majority of situations will have the airborne noise as the dominant component.

When a railway runs in a tunnel, there is no airborne noise component. As such, the groundborne noise is heard in isolation. This, coupled with the lack of any visual stimulus for the passing trains, makes groundborne noise a particular consideration when planning new underground railways.

Groundborne noise has a particular difference to most sources of environmental noise. When considering noise from sources such as surface railways or highways, the noise that is heard inside a building is the result of the noise that transmits through the façade of the building, typically through the windows. As such, if levels of environmental noise are considered to be too high within a building, it is possible to reduce these noise levels by increasing the performance of the installed glazing.

This is not possible for groundborne noise since the sound is caused by the response of internal building elements to external vibration. As such, increasing glazing performance will have no effect on the groundborne noise. It may even have the reverse effect since increased glazing performance can decrease background noise levels within rooms, which may make the groundborne noise more noticeable.

Therefore, it is very difficult to provide mitigation to buildings located close to underground railways. The most effective method of mitigating groundborne noise is through the careful design of the railway to minimise the vibration at the source.

Groundborne vibration is produced by the interaction of the wheels and rails. This radiates the vibration from the base of the tunnel. One aspect of this phenomenon is that the presence of the tunnel provides what is effectively a screen to the vibration produced at the base of the tunnel. This results in a 'shadow' area directly above the tunnel and the highest levels of vibration are typically found a few metres to the side of the tunnel alignment.

3 ASSESSMENT CRITERIA

When developing the criteria used in the NLE noise and vibration chapter, cognisance was given to those used on previous projects. A detailed discussion of the proposed criteria is provided in Annex A.

There has been a history of building new underground railway lines under London in recent years. Projects such as HS1, Jubilee Line Extension and Crossrail have all introduced new underground railways and have assessed groundborne noise effects as part of their environmental statements. The most recent underground railway project from which to draw appropriate assessment criteria is the Crossrail project. The Crossrail project has published the Environmental Statement[Ref. 1] that supported the Hybrid Bill process that granted permission for the construction of the railway.

3.1 Groundborne Noise

The Crossrail project, due to its large spatial scope, included a detailed set of groundborne noise assessment criteria that applied to the route. These criteria were published in a public Information Paper[Ref. 2] that outlined the measures that were to be put in place to control groundborne noise and vibration that may otherwise occur from the construction and operation of the railway. These criteria are reproduced in Table 1.

TABLE 1: CROSSRAIL GROUNDBORNE NOISE SIGNIFICANCE CRITERIA

Building	Level/Measure
Residential buildings	40 dB L_{ASmax}
Offices	40 dB L_{ASmax}
Hotel	40 dB L_{ASmax}
Theatres	25 dB L_{ASmax}
Large Auditoria/Concert Halls	25 dB L_{ASmax}
Sound recording studios	30 dB L_{ASmax}
Places of meeting for religious worship	35 dB L_{ASmax}
Courts, lecture theatres	35 dB L_{ASmax}
Small Auditoria/halls	35 dB L_{ASmax}
Schools Colleges	40 dB L_{ASmax}
Hospitals, laboratories	40 dB L_{ASmax}
Libraries	40 dB L_{ASmax}

Table 1 provides a comprehensive set of assessment criteria that could be applied to any building. However, when the scoping for the Northern Line Extension was carried out, all noise sensitive receptors located close to the route were considered to have the same sensitivity. This means that all of the receptors along the NLE fall into the 40 dB L_{ASmax} criterion, when considering the building usage under the Crossrail scheme. Therefore, the assessment criteria have been simplified to a single groundborne noise criterion.

Since the production of the Crossrail Environmental Statement, London Underground has published its own guidance[Ref. 3] for noise and vibration from newly constructed infrastructure and assets. This guidance states that groundborne noise from newly constructed subsurface railways is not considered significant if the average maximum noise level does not exceed 40 dB L_{AFmax}.

This is a departure from previous projects in that London Underground require the assessment of groundborne noise levels using the 'Fast' time weighting. All previous projects have used the 'Slow' time weighting. To understand the impact that this has on noise levels, it is necessary to understand the difference between the two metrics.

When measuring the maximum sound pressure level, the measuring instrumentation includes the effect of a time constant. This time constant is either set to 'Fast', which approximately equates to a 125 millisecond time constant, or 'Slow; which approximately equates to a 1 second time constant. When measuring transient sources of noise, such as those from train pass bys, the time constant can have quite a large influence on the measured maximum noise levels.

For groundborne noise, it has been found that the 'Fast' time constant provides maximum noise levels that are typically 2 to 4 dB higher than when measured with the 'Slow' time constant[Ref. 4]. A difference of 2 dB is expected for smooth continuously welded rails and a difference closer to 4 dB is expected for jointed track.

The groundborne noise significance criteria used for the NLE are provided in Table 2.

TABLE 2: SIGNIFICANCE OF GROUNDBORNE NOISE EFFECTS

Internal* Noise Level Due to a Train Pass-by (dB L_{AFmax})	Significance of Effect
≤ 35	Negligible
36 - 40	Minor Adverse
41 - 45	Moderate Adverse
≥ 46	Major Adverse

**internal refers to noise levels which are experienced in a ground floor living room or bedroom of any lawfully occupied residential property above the line.*

These groundborne noise significance criteria are based on L_{AFmax} rather than the L_{ASmax} criteria used for previous projects. Therefore, since it is know that the L_{AFmax} is between 2 and 4 dB greater than the L_{ASmax}, the assessment of groundborne noise for the Northern Line Extension has considered that a significant groundborne noise level occurs 2 to 4 dB lower than has been the case for previous projects.

3.2 Groundborne Vibration

The most recent relevant project that can be used for the determination of suitable significance criteria for groundborne vibration is the Crossrail project. However, since the production of the Crossrail ES, a number of key British Standards with regard to vibration have been revised and published as new editions. Therefore, the significance criteria used in the NLE assessment have been based on guidance from the revised British Standards.

The assessment of vibration affecting humans in buildings is made in accordance with BS 6472-1:2008[Ref. 6] by considering the Vibration Dose Value (VDV) levels in $m/s^{1.75}$. The Vibration Dose Value is a quantity that is used for assessing whole body vibration and is the fourth root of the integral of the fourth power of acceleration after it has been frequency weighted. This is used as the method for assessing the significance of whole body vibration.

Within BS 6472-1:2008, the assessment of whole body vibration is provided in terms of varying degrees of adverse comment. These give the assessor some guidance on the general suitability of the vibration levels under assessment. These varying degrees of adverse

comment, along with the VDV levels at which they occur have been used in the determination of the significance criteria for the NLE. Table 3 sets out the criteria used in the assessment.

TABLE 3: SIGNIFICANCE CRITERIA FOR WHOLE BODY VIBRATION

Period	Adverse Comment Not Expected	Low Probability of Adverse Comment	Adverse Comment Possible	Adverse Comment Probable	Adverse Comment Very Likely
Residential 16 Hour Daytime	<0.2	0.2 - 0.4	0.4 – 0.8	0.8 – 1.6	> 1.6
Residential 8 Hour Night-time	<0.1	0.1 – 0.2	0.2 – 0.4	0.4 – 0.8	> 0.8
Significance of Effect	Negligible	Minor Adverse	Moderate Adverse	Major Adverse	Major Adverse

A significant effect is considered to have occurred if the vibration levels are predicted to give rise to a moderate or major effect. It should be noted that the significance criteria apply to residential buildings. BS 6472-1:2008 advises that should the building under assessment be commercial, the levels in Table 3 should be doubled.

4 PREDICTION OF GROUNDBORNE NOISE AND VIBRATION

The modelling and prediction of groundborne noise and vibration is a challenging task. The prediction of vibration through the soil at distances removed from the track is difficult, as the soil/ subsoil structure can vary from one site to another. The transmission of vibration waves through soils and rock is mathematically very complex to calculate as, when boundaries are present, such as layers of soil or rock or building foundations, waves can be attenuated or enhanced by refraction and interference. It is not always possible to account for such phenomena.

To ensure that the prediction of vibration takes cognisance of as many of these different phenomena as possible, the prediction of groundborne noise and vibration is based primarily on empirical data for vibration produced by trains. Mathematical modelling is used to support the predictions where the use of empirical modelling is not possible.

The prediction of noise and vibration due to underground rail traffic is based on measurements of the vibration and groundborne noise due to an existing London Underground railway line which has similar construction, depth and ground conditions to those applicable to the NLE. The Victoria line was selected as the basis for the empirical modelling since it has similar depth and ground conditions to the proposed NLE route.

To allow the prediction of operational groundborne noise and vibration for the proposed NLE, measurements were taken at various locations in the vibration transmission path between the track and the receiver:

- the tunnel invert;
- the tunnel wall;
- the ground surface; and
- within properties above the line.

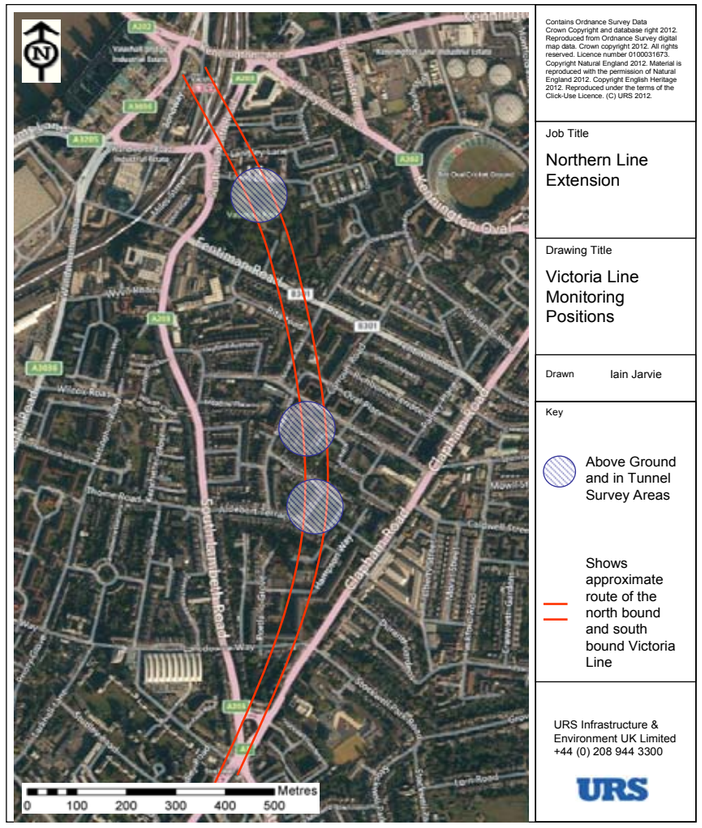
The measurement of vibration at each of these locations allows the understanding of the complete vibration propagation path from the source (track) to the receiver (building).

4.1 Victoria Line Measurements

Measurements of vibration from the Victoria line have been carried out at three locations. These locations were selected due to there being access to locations within the tunnel to leave the appropriate measuring instrumentation and because they had surface locations where the decay of vibration from the line could be measured. These were all important aspects of the prediction process that required consideration in the source data acquisition.

A map showing the chosen measurement locations is provided in Figure 2.

FIGURE 2: VICTORIA LINE SURVEY LOCATIONS



The measurement of vibration inside the tunnels was facilitated by London Underground, who provided the necessary instrumentation and undertook the measurements with support from URS. The measurements carried out consisted of acquisition of the vibration levels due to

passing trains at the tunnel invert and wall. The levels of railhead roughness were also measured.

The track that is installed in the Victoria line tunnel was either on concrete or timber sleepers. Photographs of the trackforms are provided in Figure 3.

FIGURE 3: EXAMPLES OF TRACK CONFIGURATIONS MEASURED ON THE VICTORIA LINE

Concrete Sleepers	Timber Sleepers
	

At the same time as the vibration levels were measured in the tunnels, vibration levels were measured on the ground surface by URS. These were measured to understand how much of the vibration present in the tunnel propagates to the surface and also to understand how the vibration decays with distance from the tunnel alignment.

4.2 In Property Surveys

To provide a baseline for the levels of groundborne noise that occur due to the existing Northern line, measurements of the groundborne noise and vibration levels that occur above the existing Northern line have been carried out.

Measurements have been carried out at 27 Albert Square, which is located close to the Victoria line and Northern line. This property has been used to determine the levels of groundborne noise that can be expected from underground lines similar to the NLE. These data form a useful set of data for understanding the levels of groundborne noise that can be expected from the NLE upon completion.

Measurements have additionally been carried out in 11 Ravensdon Street. The measurements were carried out in a building that is located directly above the Northern line loop (the Kennington loop) immediately south of Kennington station. At this location, the track level is around 18 m below ground level, which is approximately equivalent to the shallowest depth proposed for the NLE. It is also understood that the track on this section of the Northern line Kennington loop is continuously welded. The trains travel around the Kennington loop at slow speed and there will be additional vibration generated by the curving forces that are not usually present on tangent track or large radius curves. The vibration levels measured in this property are likely to be higher than would be expected from the NLE. However, the low background noise inside this property made the measurements a good dataset for validation of the Kurzweil formula[Ref. 5] used in the prediction, more of which is explained in section 4.3.

4.3 Prediction Methodology

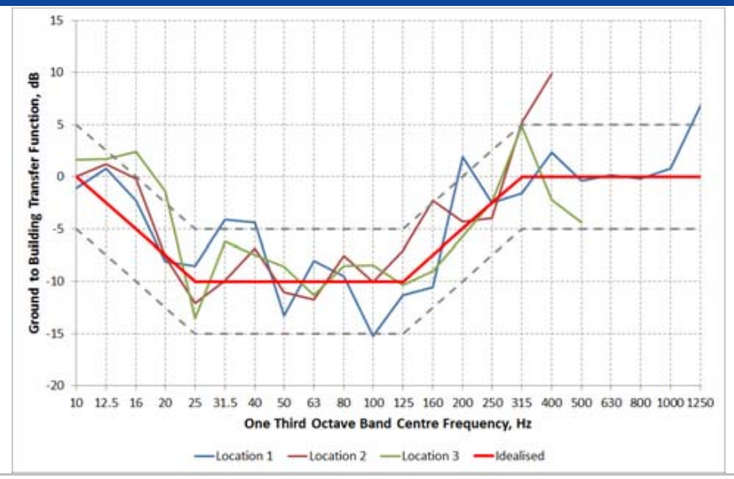
The prediction methodology used by URS in the preparation of the NLE is based primarily on empirical modelling using the data acquired from the surveys described above and also data acquired by URS in other ground vibration studies.

The most important quantity in the prediction of vibration is the level that will occur on the ground surface. This has been studied in the Victoria line surveys. The measured data have been used to derive an empirical prediction model which is based on the Victoria line. The Victoria line was used as the closest accessible railway that runs through the same ground types as the NLE and is most representative of the expected final design of the NLE. This model has been developed to be used on the NLE and has been used to understand the vibration levels and how they decay with distance from the tunnel alignment.

4.3.1 Vibration Transfer Functions

The next element of the process involves predicting how the vibration transfers from the ground into buildings. Due to the large variability between different types of structures and their foundations, this can lead to a high degree of uncertainty. It is possible to use data from standard text books; however, most of the books that study this phenomenon in detail are for other countries and URS do not know of any studies that provide data for typical UK building constructions. To provide further confidence in the use of these ground-to-building transfer functions, measurements have been made of such transfer functions at a number of buildings that are typical of those along the proposed NLE route. The results of these measurements are provided in Figure 4.

FIGURE 4: MEASURED GROUND TO BUILDING TRANSFER FUNCTIONS



The results in Figure 4 provide data measured from three locations close to the existing Northern line along with an idealised relationship that provides an average transfer function. To account for the variability between sites, this idealised transfer function has a +5 dB

tolerance which is added to provide an idealised maximum vibration transfer function for the predictions.

An additional correct has been included for locations close to the two proposed step plate junctions and the crossover at Battersea, where the presence of the junctions are expected to lead to an increase in vibration. However, this will be localised to areas close to the junctions and it has been assumed that the remainder of the NLE consists of continuously welded rail.

4.3.2 Relationship Between VDV and eVDV

This vibration transfer function allows the prediction of the floor vibration inside a building. This predicted floor vibration is used in the assessment of whole body vibration levels through the use of the Vibration Dose Value (VDV). The calculation of VDV strictly requires the use of time history data. However, the 1992 version of BS 6472 included the use of the estimated Vibration Dose Value (eVDV) which allowed the use of one third octave band data to calculate an estimated VDV. BS 6472:2008 advises use of the estimated vibration dose value only as an approximation to the vibration dose value for vibration that is not time-varying in magnitude and has a crest factor which is below about six, and includes eVDV in its informative Appendix C.

The equation for the eVDV provided in BS 6472:1992 is reproduced below:

$$eVDV = 1.4 \times a_w(t) \times t^{0.25}$$

where $a_w(t)$ is the frequency weighted vibration in m/s^2
t is the time for which the vibration event is present in seconds

Empirical data were used to define the factor of 1.4 in the eVDV equation. This factor is based on a range of signals with low crest factors.

To validate the use of the eVDV, the data gathered from the surveys above the existing Northern line have been used to calculate the VDV and the eVDV and the two metrics have been compared. The data gathered show that the eVDV calculates the VDV to within 93.5 % of its true value. Therefore, the use of the eVDV as a method of calculating vibration exposure inside buildings is considered reasonable.

4.3.3 Prediction of Groundborne Noise

The predicted floor vibration is then used to predict the groundborne noise inside the properties. This is done using an empirical equation known as the Kurzweil formula[Ref. 5]. The Kurzweil formula is provided below.

$$L_p = L_a - 20 \times \log_{10}(f) + 17$$

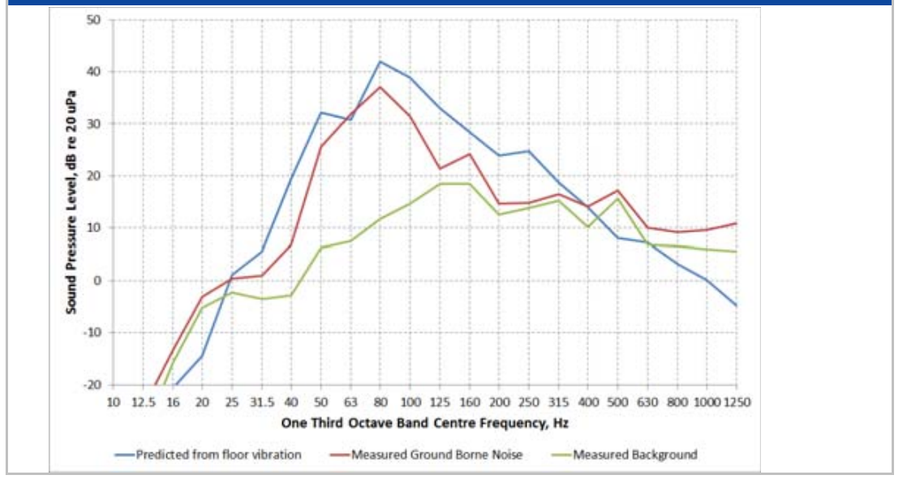
where L_p is the L_{ASmax} in dB re 20 μPa
L_a is the average floor vibration acceleration level in dB re $1x10^{-6}$ m/s^2
f is the frequency of the vibration

This equation is based on data gathered in properties above the Toronto metro system during the 1970s. The data gathered during the in-property measurements taken for the NLE

assessment work have been analysed to determine if the equation holds for the particular situation of the NLE.

The floor vibration levels that were measured in 11 Ravensdon Street were analysed and the Kurzweil formula applied. The results have been compared with the measured groundborne noise levels. This comparison is presented in Figure 5.

FIGURE 5: VALIDATION OF THE KURZWEIL FORMULA FOR NLE



It can be seen that the Kurzweil formula provides a very good estimation of the groundborne noise levels. There is some variation for frequencies above 250 Hz; however, it can be seen that this is due to the presence of background noise not attributable to the passage of trains.

The results of this validation show that the Kurzweil formula over-predicts the groundborne noise level by approximately 5 dB. This is supported by further evidence in a recent research paper[Ref. 7] that provides the same conclusion. Therefore, the use of this equation is considered to be a conservative approach in the estimation of groundborne noise based on floor vibration levels.

The groundborne noise criteria that are being used on the NLE are based on the L_{AFmax} rather than the L_{ASmax} traditionally used for groundborne noise assessments. The measurements undertaken at Ravensdon Street have been used to verify the relationship between the L_{ASmax} and the L_{AFmax}. The results of this analysis are presented in Figure 6.

FIGURE 6: DIFFERENCE BETWEEN L_{ASMAX} AND L_{AFMAX}

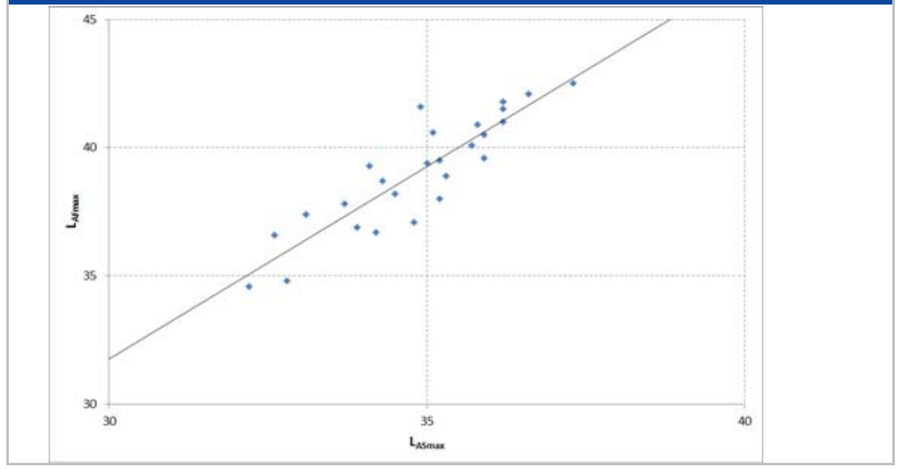


Figure 6 shows that there is typically 4 dB difference between the L_{ASmax} and the L_{AFmax}. This is expected since the track in the tunnel beneath this property is likely to cause some degree of impulsivity in the vibration, due to curving effects inducing a stick-slip action at the wheel-rail interface.

4.3.4 Assumptions

The following assumptions have been used in the production of the groundborne noise and vibration predictions within this ES:

- ground conditions are similar to those at the source data measurement locations;
- track will be continuously welded rail with the exceptions of the step plate junctions and the crossover at Battersea;
- trains have similar suspension characteristics and wheel roughness levels to Victoria line rolling stock;
- rail roughness levels are comparable to those at the source data measurement sites; and
- the trackform used for the step plate junctions will be the same as for the rest of the NLE, particularly the mitigated case where it has been assumed to be on track with the same performance as JLE baseplates.

5 RESULTS

The data acquired from the measurement surveys have been analysed to determine the vibration levels that occur at each survey location.

5.1 Victoria Line Surveys

The vibration levels measured within the Victoria line tunnels and on the ground surface above the tunnels have been analysed to determine the vibration transfer through the ground. A pictorial representation of the measurements is provided in Figure 7.

FIGURE 7: MEASUREMENT POSITION AND EXAMPLE OF MEASURED VIBRATION DATA

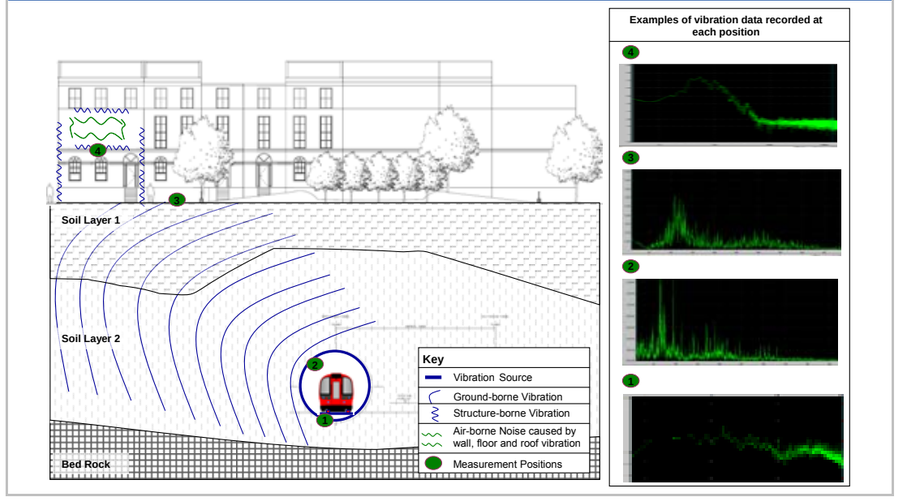
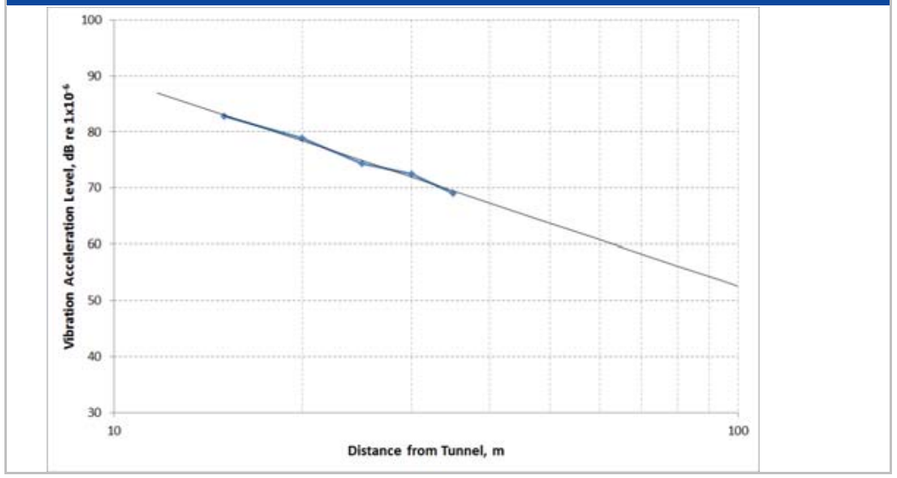


Figure 7 shows how the vibration level changes as the vibration propagates from the source to the receiver.

One of the most important aspects of the Victoria line surveys was to measure the vibration at the ground surface at different distances from the tunnel alignment. This was undertaken to understand how the vibration decays with distance from the tunnel alignment. The results of the decay with distance measurements are presented in Figure 8.

FIGURE 8: MEASURED DECAY WITH DISTANCE OF VIBRATION



These results show a logarithmic decay with distance up to 35 m from the tunnel alignment, as would be expected. At distances further than 35 m from the track, the background vibration levels provided too much contribution to the overall vibration level to allow a valid extrapolation to be completed.

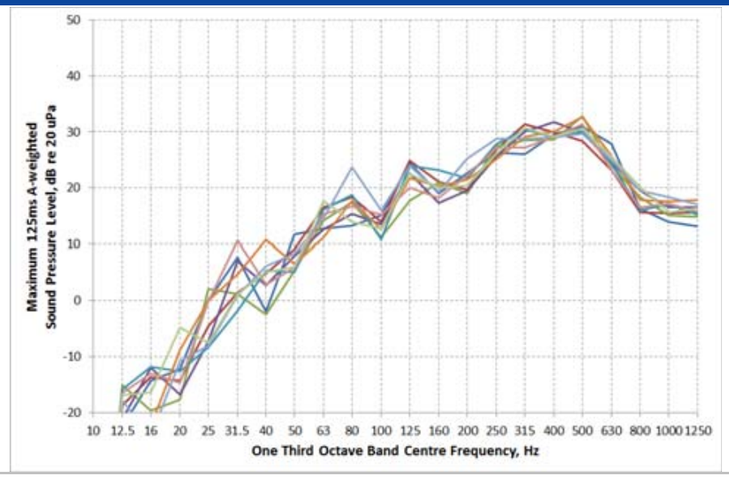
5.2 In Property Surveys

The measurements of the existing groundborne noise in properties close to the Northern and Victoria lines provide the most useful set of data for inclusion in the modelling. These measurements allow several aspects of the prediction methodology to be further verified.

Measurements have been undertaken of the groundborne noise and the floor vibration within 27 Albert Square. This property is close to the Victoria line and provides a good indication of the groundborne noise levels that can be expected from the NLE with no track mitigation. At this location, the tunnels are located in the same type of ground conditions at a similar depth with the similar rolling stock at similar speeds to those proposed for the NLE. The only major difference will be the design of the track, which is standard LUL trackforms for the Victoria line.

Groundborne noise and vibration levels were measured inside the property for a number of trains. The results for a number of northbound Victoria line trains are presented in Figure 9.

FIGURE 9: MEASURED GROUNDBORNE NOISE



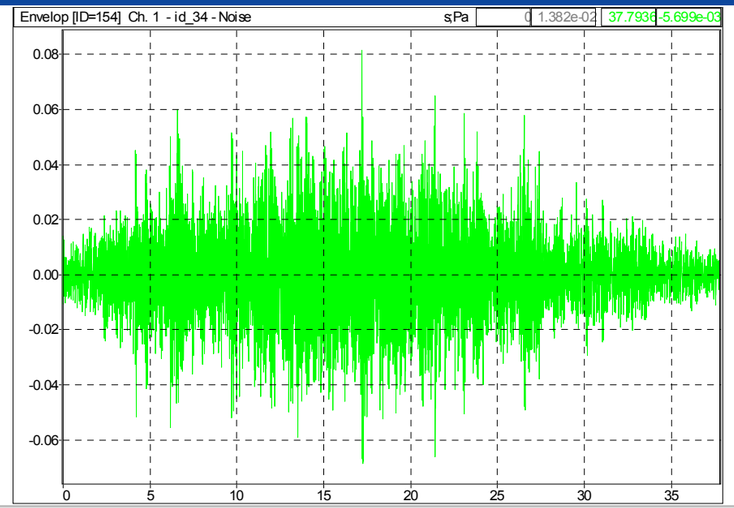
These data show the levels that are considered to be typical of the groundborne noise levels that can be expected from the NLE with no track mitigation.

The results of the analysis at this location have shown that the measured groundborne noise levels at 27 Albert Square are typically 37 dB L_{AFmax} for the northbound track, which is approximately 40 m from the measurement location. The measured groundborne noise levels from the southbound track, which is approximately 12 m from the measurement location, were typically 42 dB L_{AFmax}. These measurements show that groundborne noise levels of the order of the measured L_{AFmax} of 42 dB can be expected for the NLE for the unmitigated case.

The measurements carried out at 11 Ravensdon Street consisted of measurements of floor vibration and groundborne noise. This property is located directly above the Northern line Kennington loop and this tunnel is at approximately the same depth as the shallowest point on the NLE. However, the slow speed of trains and the relatively small curve radius on this section of track means that the levels measured in this property are unlikely to be directly comparable to the NLE.

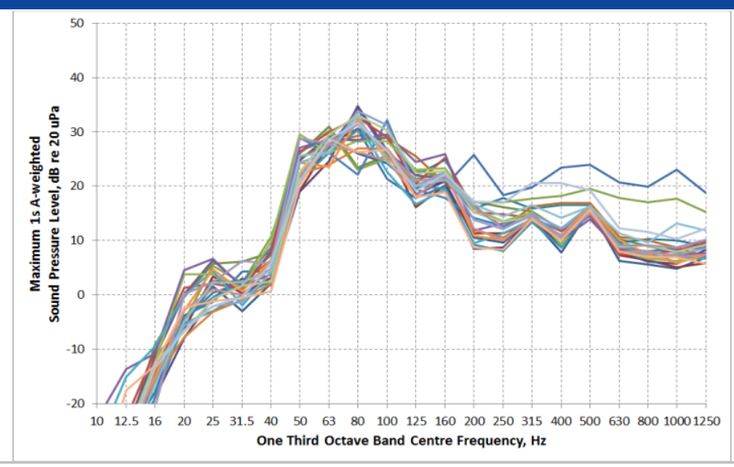
The measurement carried out in 11 Ravensdon Street captured raw time history data to allow the analysis in whichever method is the most appropriate. An example of the typical groundborne noise time history for a train pass by is shown in Figure 10.

FIGURE 10: MEASURED GROUNDBORNE NOISE TIME HISTORY



The raw groundborne noise and vibration data have been analysed to determine the typical floor vibration and groundborne noise levels that occur due to trains at this location. The results of this analysis for a number of trains are presented in Figure 11.

FIGURE 11: MEASURED GROUNDBORNE NOISE SPECTRA



These results show the spread of data is quite low with less than 10 dB variation between maximum and minimum event levels. The spread in the results above the 160 Hz band is due to variations in the background noise, which are typically dominated by sources of noise external to the property.

The in-property measurements have been used to provide verification of several of the assumptions used in the prediction methodology. These have been discussed in detail earlier in this Appendix.

The typical levels of groundborne noise measured inside 11 Ravensdon Street were 35 dB L_{ASmax} and 39 dB L_{AFmax}.

5.3 Predicted Groundborne Noise and Vibration Results for NLE – No Mitigation

The groundborne vibration levels have been predicted for buildings close to the alignment of the NLE. These predictions have allowed the calculation of the eVDV from a single train pass by. This has been used in conjunction with the expected maximum service frequency, which is expected to occur in 2031 and will be 28 trains per hour in each direction.

The predicted Vibration Dose Values for the day and night periods are provided in Table 4. These have been predicted as the selected groundborne noise sensitive receptors shown in Figure E4-1 in Annex B.

TABLE 4: PREDICTED GROUNDBORNE VIBRATION LEVELS

Receptor	Vibration Dose Value (VDV_b), $m/s^{1.75}$	
	Day (07:00 – 23:00)	Night (23:00 – 07:00)
Adrian House, Wandsworth Road	0.051	0.036
Mawbey Brough Health Centre	0.051	0.036
1 Dorset Road	0.051	0.036
64 Meadows Road	0.045	0.032
71 Fentiman Road	0.025	0.018
17 Carroun Road	0.023	0.016
24 Claylands Road	0.029	0.02
Ashmole Primary School	0.051	0.036
56 Hanover Gardens	0.051	0.036
Lockwood House, Kennington Oval	0.051	0.036
Henry Fawcett Junior School	0.051	0.036
16 Aulton Place	0.083	0.059
87 De Laune Street	0.148	0.105

The predicted VDV_b values in Table 4 are for the vertical direction only. Vibration from trains typically produces more environmental vibration in the vertical axis than in the lateral axes. Therefore, the prediction of vibration has been undertaken for the vertical axis only since this will yield a higher VDV.

These predicted values, when compared with the significance criteria in Table 3, show that there is expected to be a negligible significance during the day and minor adverse significance during the night at one location only, namely 87 De Laune St, where the additional vibration from the step plate junction is expected to increase vibration levels to minor adverse. For all other receptor locations, the nighttime vibration levels are predicted to be negligible.

The predicted groundborne vibration levels have been used to calculate the groundborne noise levels along the route and at the chosen selected receptors. The groundborne noise contour plots are presented in Annex B. These results for the chosen receptors are provided in Table 5. A map of the chosen receptor locations are shown in Figure E4-1 in Annex B.

TABLE 5: PREDICTED UNMITIGATED GROUNDBORNE NOISE LEVELS

Receptor	Predicted L_{AFmax}, dB
Adrian House, Wandsworth Road	38
Mawbey Brough Health Centre	38
1 Dorset Road	38
64 Meadows Road	37
71 Fentiman Road	32
17 Carroun Road	31
24 Claylands Road	33
Ashmole Primary School	38
56 Hanover Gardens	38
Lockwood House, Kennington Oval	38
Henry Fawcett Junior School	38
16 Aulton Place	40
87 De Laune Street	45

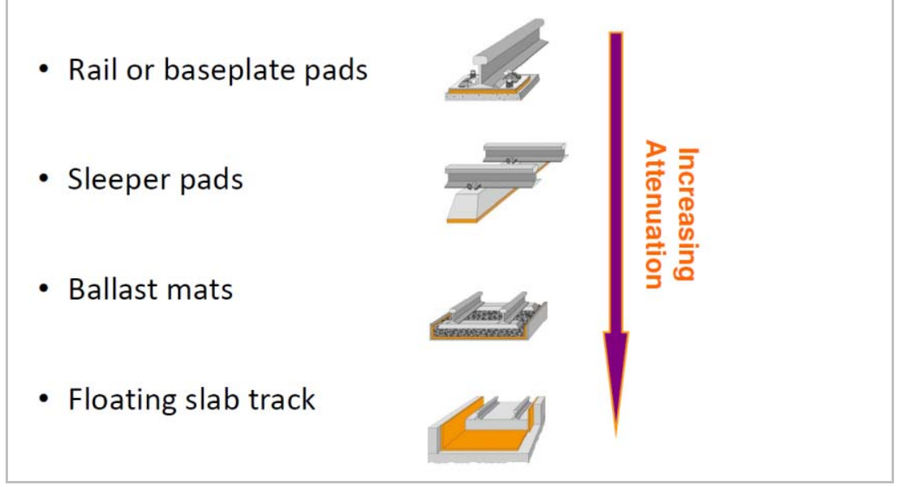
These are predicted for receptors slightly to the side of the tunnel alignment, typically 5-20 m to the side, where groundborne noise levels are at their highest. These results show that for the unmitigated case the predicted groundborne noise levels provide a negligible to minor adverse effect. Although the chosen receptor location close to the southbound step plate junction (87 De Laune Street) is predicted to have a moderate adverse effect. Therefore, the overall effect is predicted to be no worse than moderate adverse.

These predictions have been based on the measurements of vibration levels above the existing Victoria line. The track that is used on the Victoria line where the measurements were carried out is standard LUL track. This has very little resilience included in the design and as such is expected to provide a worst-case assessment of the groundborne noise levels that can occur as a result of the operation of the NLE with no track mitigation.

6 MITIGATION

The initial assumption for the groundborne noise modelling is to assume standard LUL trackform, which does not have vibration mitigation. Different track systems provide different degrees of vibration isolation, examples of which are shown in Figure 12.

FIGURE 12: TRACK ISOLATION METHODS



The potential consequence of many low vibration trackforms is increased construction depth, which has a subsequent effect in terms of tunnel diameter, which can increase construction costs considerably. The amount of attenuation required to reduce the predicted levels to less than the significance criterion is 5 dB. Therefore, it is likely that a resilient baseplate system would be the most appropriate system to consider in terms of mitigation.

It should also be noted that it is current best practice to install trackforms in new railway tunnels that have some degree of vibration isolation for engineering reasons other than the control of groundborne noise.

The final trackform selection will be the responsibility of the design and build contractor in conjunction with LUL. However, for the purposes of this assessment, it has been assumed that the track to be installed gives the same vibration performance as the system of resilient baseplates installed on the Jubilee Line Extension. These baseplates provide a resilient layer underneath the rail baseplate between the baseplate and the concrete track slab.

This resilient baseplate system has been modelled by Rupert Taylor Ltd to determine the expected insertion gain of the trackform. The insertion gain is the amount by which the vibration is increased due to insertion of the resilient baseplates into the track system. The insertion gain is usually a negative number in the region where the baseplate is providing isolation and as such is providing a reduction in vibration. This insertion gain has been applied to the modelling results to predict the effect of the use of the JLE baseplate system.

The use of a system with the same performance as the JLE baseplate system is expected to provide 10 dB reduction of the overall A-weighted groundborne noise levels.

The effects of the use of a trackform with the same vibration performance as the JLE baseplate system have been incorporated into the groundborne vibration modelling and the predicted groundborne vibration levels at the selected chosen receptors and are provided in Table 6. A map of the chosen receptor locations are shown in Figure E4-1 in Annex B.

TABLE 6: PREDICTED MITIGATED GROUNDBORNE VIBRATION LEVELS

Receptor	Vibration Dose Value (VDV_b), $m/s^{1.75}$	
	Day (07:00 – 23:00)	Night (23:00 – 07:00)
Adrian House, Wandsworth Road	0.025	0.018
Mawbey Brough Health Centre	0.025	0.018
1 Dorset Road	0.025	0.018
64 Meadows Road	0.022	0.016
71 Fentiman Road	0.013	0.009
17 Carroun Road	0.011	0.008
24 Claylands Road	0.014	0.01
Ashmole Primary School	0.025	0.018
56 Hanover Gardens	0.025	0.018
Lockwood House, Kennington Oval	0.025	0.018
Henry Fawcett Junior School	0.025	0.018
16 Aulton Place	0.047	0.033
87 De Laune Street	0.083	0.059

The proposed vibration mitigation is providing VDV_b levels that are approximately halved from the unmitigated case where the track runs on continuously welded rail. The frequency dependant correction used for the increase due to the step plate junction means that the VDV_b is reduced by slightly less than half for the locations affected by the step plate junction. This is less than the 10 dB that the proposed mitigation provides for groundborne noise due to the frequency dependent nature of the insertion gain affecting the dominant frequencies for groundborne vibration less than those for groundborne noise. The mitigated groundborne vibration levels have been reduced to 'adverse comment not expected' for both the day and night periods. Therefore, the significance of the residual effect is negligible.

To determine the effects of the mitigated groundborne noise levels, the effect of the use of the JLE baseplate system has been plotted on a series of maps which are shown in Annex B. These maps show contours of the predicted mitigated groundborne noise. In addition, the groundborne noise levels have been predicted at the selected chosen receptors. These

results are presented in Table 7. A map of the chosen receptor locations are shown in Figure E4-1 in Annex B.

TABLE 7: PREDICTED MITIGATED GROUNDBORNE NOISE LEVELS

Receptor	Predicted L_{AFmax}, dB
Adrian House, Wandsworth Road	27
Mawbey Brough Health Centre	27
1 Dorset Road	27
64 Meadows Road	26
71 Fentiman Road	21
17 Carroun Road	20
24 Claylands Road	22
Ashmole Primary School	27
56 Hanover Gardens	27
Lockwood House, Kennington Oval	27
Henry Fawcett Junior School	27
16 Aulton Place	30
87 De Laune Street	35

It has been predicted that groundborne noise levels are expected to be no more than 35 dB L_{AFmax} for all locations along the route. Therefore, assuming that the final track system provides the same level of performance as the JLE baseplate system, the residual effect is negligible.

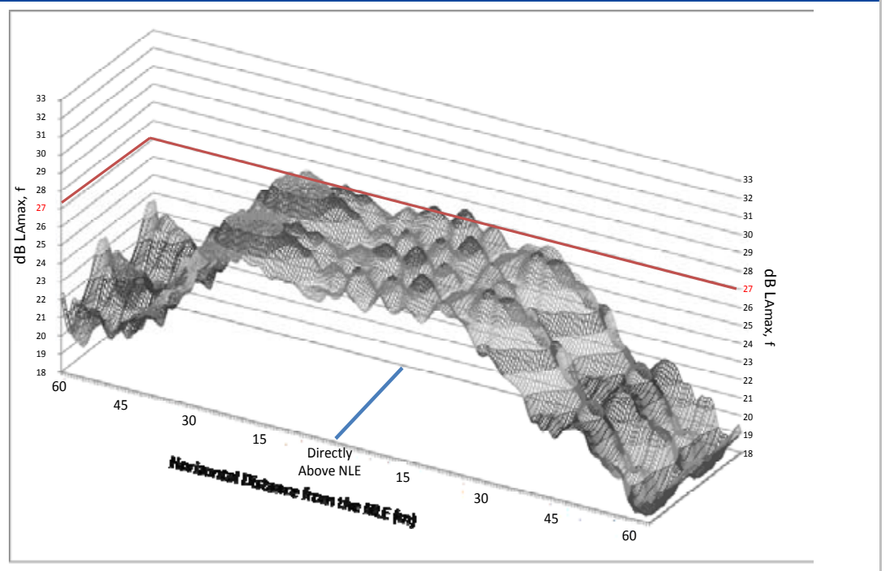
6.1 Model Validation using FINDWAVE

This prediction model has been validated using Rupert Taylor's FINDWAVE® model. FINDWAVE® is a fully three-dimensional finite-difference time-domain model specifically developed for modelling vibration and groundborne noise from underground railways. It has been used on many projects around the world, including Crossrail, Thameslink 2000, Jubilee Line Extension, Channel Tunnel Rail Link and Docklands Light Railway in London. FINDWAVE is a finite difference time-domain numerical model for computing the propagation of waves in elastic media. The model includes the moving train, the track, tunnel and other structures, the soil and buildings above. The excitation is provided from an input file containing an assumed vertical rail head profile, together with the gravitational effect of the rolling train. The model predicts, in the time domain, the dynamic behaviour of the track and structure supporting the train, and the medium surrounding it, e.g. soil or air, together with structures below or above ground level.

A numerical model has been created using FINDWAVE for both an unmitigated tunnel (the Victoria line) and a tunnel with resiliently supported rail as described above. An example

output is shown in Figure 14 in terms of overall level (dB L_{AFmax}) as a function of distance either side of the tunnel. This takes account of local changes in geology.

FIGURE 13: FINDWAVE MODEL OUTPUT



The output from the FINDWAVE model shows good agreement the URS prediction method, which allows for further confidence in the method of groundborne noise prediction.

7 SUMMARY AND CONCLUSIONS

The operational groundborne vibration levels have been assessed and it is expected that levels will provide a negligible effect during the day and night except for one of the chosen receptor locations where there is predicted to be a minor adverse effect during the night. Therefore, no mitigation is required specifically for operational groundborne vibration.

The operational groundborne noise levels have been predicted to provide a moderate adverse effect. To reduce the effects of the groundborne noise, it has been determined that a vibration isolating track form is required in the running tunnels. The use of a vibration isolating trackform that provides the same degree of isolation as the JLE baseplate system is predicted to reduce the predicted groundborne noise levels to no more than 35 dB L_{AFmax}, which is a negligible effect. This also has the effect of reducing the operational groundborne vibration effects to negligible for both the day and night.

Therefore, it is expected that the provision of a trackform that provides the same degree of vibration isolation as the JLE baseplate system will ensure that residual effects from groundborne noise and vibration are negligible.

8 REFERENCES

Ref. 1 Crossrail Environmental Statement

Ref. 2 Crossrail Information Paper D10 – Groundborne Noise and Vibration, Version 4 03/04/08

Ref. 3 London Underground Guidance Document G1323 Noise and Vibration Asset Design Guidance Issue A1 April 2012

Ref. 4 British Standard ISO 14827-1:2005 Mechanical vibration — Groundborne noise and arising from rail systems — Part 1: General guidance

Ref. 5 Transportation Noise Reference Book, PM Nelson, Butterworths, 1987

Ref. 6 British Standard 6472-1:2008

Ref. 7 Transit Cooperative Research Program, Web-Only Document 48: Groundborne Noise and Vibration in Buildings Caused by Rail Transit, Dec 2009

ANNEX A: GROUNDBORNE NOISE BENCHMARKING

RUPERT TAYLOR
ACOUSTICS - NOISE - VIBRATION

Northern Line Extension – Groundborne Noise – Benchmarking

The assessment of groundborne noise from underground railways is, almost universally around the world, carried out by reference to the maximum noise level during the passage of a train. This is a different approach to the assessment of airborne noise from surface sources such as road traffic, where an energy average over a period of time, such as an 8-hour night, is frequently used.

Groundborne noise differs from airborne noise in a number of ways, two of the most important being that whereas one can close or double glaze windows to reduce road traffic noise this would not reduce groundborne noise. Likewise, in a house affected by road traffic noise it is often possible to find lower noise levels in a room with windows in a quieter façade, and this is not possible with groundborne noise which tends to be similar in level in all rooms on each floor.

For these reasons criteria for groundborne noise tend to be much stricter than those for airborne noise. If the guidance for airborne noise (for example WHO guidance) is looked at in terms of equivalent maximum noise levels from passing trains, this leads to maximum noise limits above those which have been adopted as criteria for groundborne noise.

Maximum noise levels are the highest value reached on a sound level meter using the standard scale for environmental noise known as A-weighted decibels, denoted dBA or dB(A). Because sound levels fluctuate, measurement of them involves a short-term averaging process, and there are two standard time constants used, “fast” or “F” and “slow” or “S”. The “F” time constant is 1/8 second, whereas the “S” time constant is 1 second. A meter measuring on “F” setting tends to track human perception of changes in loudness. A meter using “S” setting is more sluggish in its response, but the results are more repeatable. The symbol used to label these measurements is either L_{AFmax} or L_{ASmax}.

For groundborne noise from underground railways the difference between the results obtained using L_{AFmax} and L_{ASmax} depends on the nature of the track. Underground railways in London constructed before the Jubilee Line Extension from Green Park to Stratford use jointed track, and the effect of wheels running over joints is to cause audible impulse noise which causes blips in the L_{AFmax} level, which are largely averaged out when using L_{ASmax}. In such cases the difference between the two can be 5 dB. The Jubilee Line Extension, and railways constructed after it, are designed with continuous welded rail so that there are many fewer joints, and the difference between L_{AFmax} and L_{ASmax} is less – about 2 dB. (The JLE does have block joints for signalling purposes).

The setting of criteria for groundborne noise in the UK began with the process of promoting the JLE project, and reference was made to the complaints history of London Underground. This indicated that, to quote from a statement by the then London Underground Ltd Scientific Adviser, “From an analysis of the data it was concluded that complaints can be expected when the internal noise level exceeds 40 dB(A).” The JLE project set a design aim of 40 dB L_{ASmax} for residential buildings. Evidence to this effect was given to Parliament during the passage of the Jubilee Line Act and accepted by the select committees of both houses. A similar approach was adopted by Crossrail, during the parliamentary committee stage of which there were several petitions relating to groundborne noise. The Crossrail position was set out in Information Paper D10 which sets out operational groundborne noise criteria, including a figure of 40 dB $L_{Amax,S}$ for residential properties.

During the committee stage IP D10 was amended in agreement with local authority petitioners seeking a lower figure than 40 dB with the addition of paragraph 2.14:

> "2.14 Further as paragraph 1.5 of the Environmental Minimum Requirements explains, the nominated undertaker will use reasonable endeavours to adopt mitigation measures that will further reduce any adverse environmental impacts caused by Crossrail, insofar as these mitigation measures do not add unreasonable costs to the project or unreasonable delays to the construction programme. This requirement will be applied to any residential property in which the level of groundborne noise arising from the operation of the Crossrail passenger service near the centre of any noise-sensitive room is predicted to equal or exceed 35dB $L_{Amax,S}$."

There were petitioners against the Crossrail Bill who lived close to the tunnel portals, and in response to their concerns, the House of Lords select committee asked the Promoter to ensure that floating slab track was installed in all tunnels which are routed under residential property at a depth of 15 metres or less. This was not linked to any numerical noise level.

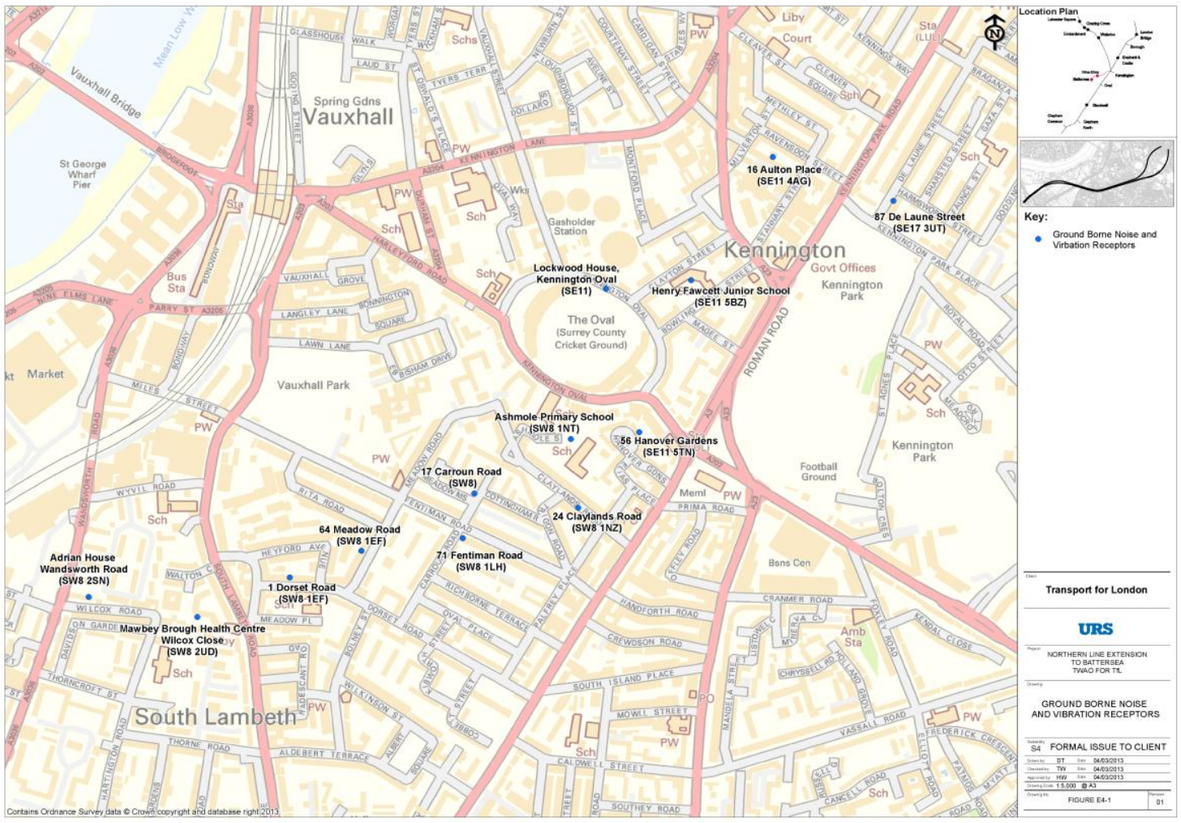
Other underground railway projects in the UK have adopted the 40 dB L_{ASmax} design target, including the DLR extensions to Lewisham and to Woolwich Arsenal.

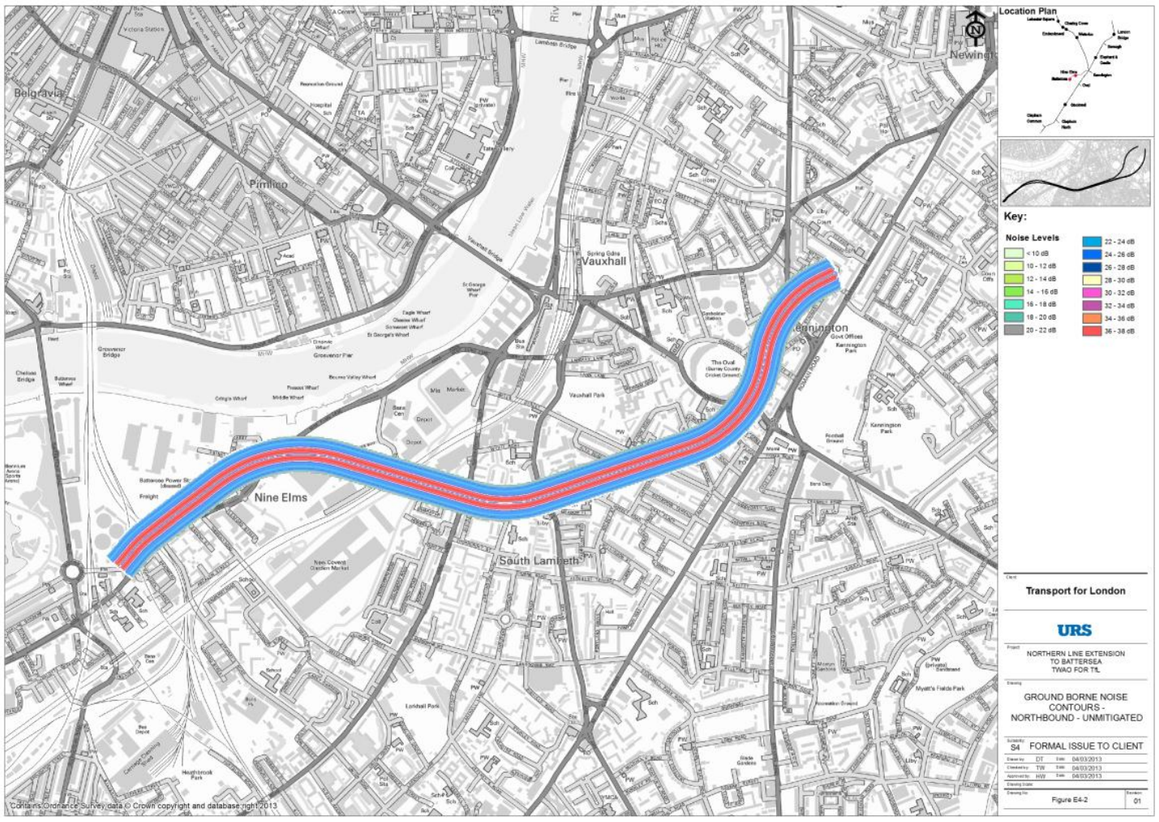
Internationally, a range of limits and design specifications have been adopted for groundborne noise. Malmö Citytunnel was required by the Swedish Environmental Court not to exceed 30 dB L_{ASMax} (with 30 dB L_{AFMax} as a goal) in housing, hospitals and churches. Australian guidance is found in "Interim Guideline for the Assessment of Noise from Rail Infrastructure Projects" which provides for 40 dB L_{ASmax} (day) and 35 dB L_{ASmax} (night). The Austrian Önorm S 9012 sets values, for satisfactory protection, of 40 dB L_{ASmax} for night where the train service ceases for four of the night hours and 35 L_{ASmax} otherwise. The figures for good protection are 5dB lower. Italian regulations set a limit of 35 dB L_{ASmax}. Norwegian Technical Regulation TEK 97 is satisfied if 32 dB L_{AFmax} is achieved in bedrooms. Västlänken in Gothenburg has a guideline value of 30 dB L_{ASmax} for bedrooms. Switzerland has a directive BEKS 1999 with a guideline value of 25 dB $L_{Aeq\ 1h}$ at night, for new construction, in residential area. The US Federal Transit Administration has impact criteria of 35 dB L_{ASmax} for residences where there are more than 70 events per day, increasing by 3 dB where there are between 70 and 30 events per day and by 8 dB where there are fewer than 30 events per day. In Ireland, both Metro North and Dart Underground have limits of 35 dB L_{ASmax} for residential area.

p

For the Northern Line Extension, TfL is committed to a noise and vibration measure for new tracks of a maximum of 40 dB L_{AFmax} and commits to use reasonable endeavours to meet a more stringent measure of 35 dB L_{AFmax}. This is a better standard that that of Crossrail by a margin equivalent to the difference between L_{ASmax} and L_{AFmax}. In some circumstances this can be as much as 5 dB. This commitment sits within the range of limits and guidance values found worldwide.

ANNEX B: GROUNDBORNE NOISE CONTOUR PLOTS


16 Aulton Place (SE11 4AG)
87 De Laune Street (SE17 3UT)
Lockwood House, Kennington Oval (SE11)
Henry Fawcett Junior School (SE11 5BZ)
Ashmole Primary School (SW8 1NT)
56 Hanover Gardens (SE11 5TN)
17 Carroun Road (SW8)
24 Claylands Road (SW8 1NZ)
64 Meadow Road (SW8 1EF)
71 Fentiman Road (SW8 1LH)
Adrian House Wandsworth Road (SW8 2SN)
1 Dorset Road (SW8 1EF)
Mawbey Brough Health Centre Wilcox Close (SW8 2UD)
Location Plan
Key:
Ground Borne Noise and Virbation Receptors
Transport for London
NORTHERN LINE EXTENSION TO BATTERSEA TWAO FOR TfL
GROUND BORNE NOISE AND VIBRATION RECEPTORS
FORMAL ISSUE TO CLIENT
FIGURE E4-1
Contains Ordnance Survey data © Crown copyright and database right 2013


Location Plan
Key:
Noise Levels
< 10 dB
10 - 12 dB
12 - 14 dB
14 - 16 dB
16 - 18 dB
18 - 20 dB
20 - 22 dB
22 - 24 dB
24 - 26 dB
26 - 28 dB
28 - 30 dB
30 - 32 dB
32 - 34 dB
34 - 36 dB
36 - 38 dB
Transport for London
NORTHERN LINE EXTENSION TO BATTERSEA TWAO FOR TfL
GROUND BORNE NOISE CONTOURS - NORTHBOUND - UNMITIGATED
FORMAL ISSUE TO CLIENT
Figure E4-2
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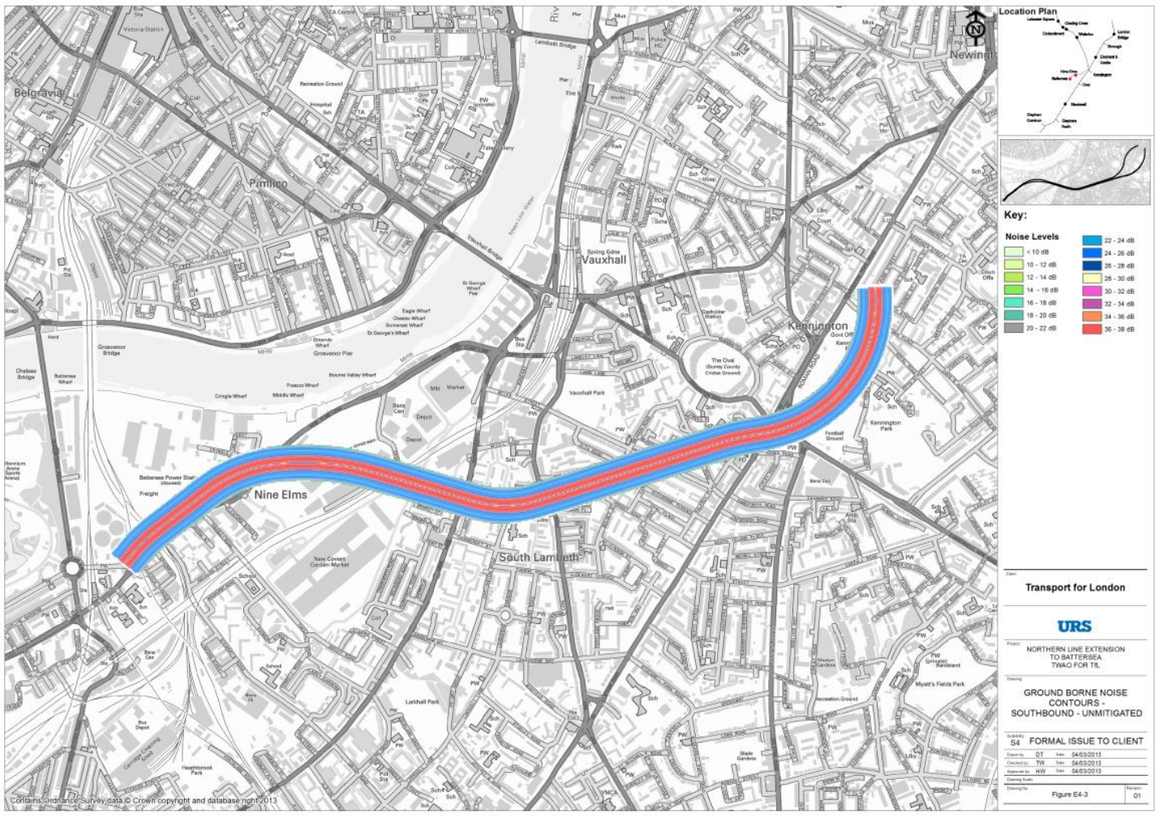
Location Plan
Key:
Noise Levels
< 10 dB
10 - 12 dB
12 - 14 dB
14 - 16 dB
16 - 18 dB
18 - 20 dB
20 - 22 dB
22 - 24 dB
24 - 26 dB
26 - 28 dB
28 - 30 dB
30 - 32 dB
32 - 34 dB
34 - 36 dB
36 - 38 dB
Transport for London
URS
NORTHERN LINE EXTENSION TO BATTERSEA TWAO FOR TfL
GROUND BORNE NOISE CONTOURS - SOUTHBOUND - UNMITIGATED
S4 FORMAL ISSUE TO CLIENT
Figure E4-3
01
Belgravia
Pimlico
Vauxhall
Kennington
Nine Elms
South Lambeth
Newington
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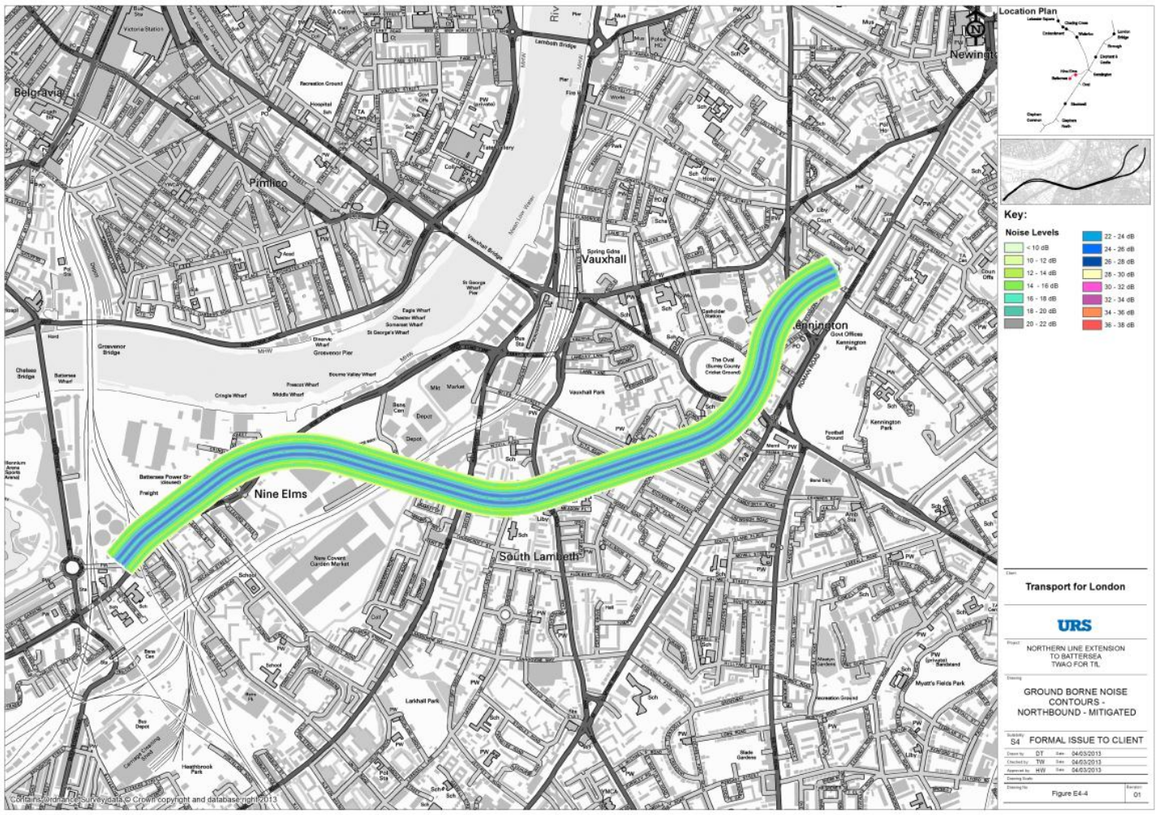
Location Plan
Key:
Noise Levels
< 10 dB
10 - 12 dB
12 - 14 dB
14 - 16 dB
16 - 18 dB
18 - 20 dB
20 - 22 dB
22 - 24 dB
24 - 26 dB
26 - 28 dB
28 - 30 dB
30 - 32 dB
32 - 34 dB
34 - 36 dB
36 - 38 dB
Transport for London
URS
NORTHERN LINE EXTENSION TO BATTERSEA TWAO FOR TfL
GROUND BORNE NOISE CONTOURS - NORTHBOUND - MITIGATED
S4 FORMAL ISSUE TO CLIENT
Figure E4-4
01
Belgravia
Pimlico
Vauxhall
Kennington
Nine Elms
South Lambeth
Newington
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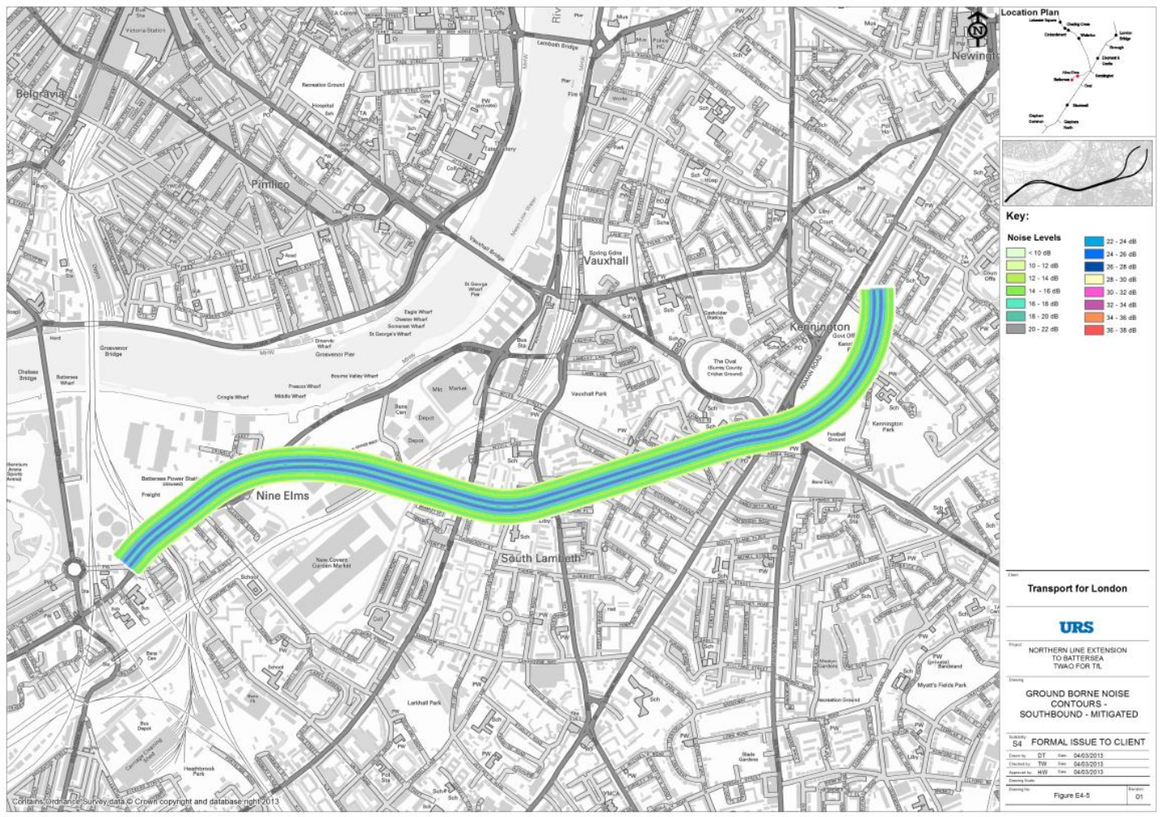
Location Plan
Key:
Noise Levels
< 10 dB
10 - 12 dB
12 - 14 dB
14 - 16 dB
16 - 18 dB
18 - 20 dB
20 - 22 dB
22 - 24 dB
24 - 26 dB
26 - 28 dB
28 - 30 dB
30 - 32 dB
32 - 34 dB
34 - 36 dB
36 - 38 dB
Transport for London
URS
NORTHERN LINE EXTENSION TO BATTERSEA TWAO FOR TfL
GROUND BORNE NOISE CONTOURS - SOUTHBOUND - MITIGATED
S4 FORMAL ISSUE TO CLIENT
Figure E4-5
01
Belgravia
Pimlico
Vauxhall
Kennington
Nine Elms
South Lambeth
Newington
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