07 Socio-economics

Environmental Statement

Volume I

07 Socio-economics

Introduction

7.1 This chapter of the Environmental Statement (ES) assesses the likely significant socio-economic impacts of the proposed Northern Line Extension (NLE). The chapter also assesses the extent to which the NLE conforms to relevant socio-economic planning policy or development strategy at appropriate spatial levels. The chapter comprises an assessment of the following potential impacts:

- Direct and indirect construction employment impacts;
- Impacts on open space users in the construction and operational phase;
- Operational employment generation;
- Access to employment opportunities (enabled by the NLE);
- Impacts on existing businesses;
- Impacts on community facility users (Kennington Park Lodge); and
- Wider socio-economic impacts to the local area and Greater London, through enabling the development of the Vauxhall Nine Elms and Battersea (VNEB) Opportunity Area (OA).

7.2 This chapter does not consider impacts on health or equalities which will be covered in the Health Impact Assessment and Equalities Impact Assessment respectively; which will be released with the Statement of Case.

7.3 This chapter describes the national, regional and local policy and strategic context; assessment methods used; baseline conditions; potential direct, indirect and induced impacts during the construction and operational phases of the NLE; wider development socio-economic impacts; mitigation measures and relevant residual and cumulative impacts.

Planning Policy Context

7.4 This section reviews those policies that are relevant to the socio-economic context of the NLE. Further details are provided in *Chapter 5: Planning Policy Context* of this ES.

National Legislation

National Planning Policy Framework (NPPF) (2012)

7.5 The NPPF (Ref. 7-1) was adopted in March 2012 and sets out the Government's economic, environmental and social planning policies for England. These policies outline the Government's vision of sustainable development, which should be interpreted and applied locally to meet local and community aspirations. The NPPF superseded a number of National Planning Policy Guidance (PPG) and Planning Policy Statements (PPS) (although some remain relevant policy) and provides overarching guidance on the Government's development aims. With respect to economic development, local planning authorities should ensure that they:

- *"Set out a clear economic vision and strategy for their area which positively and proactively encourages sustainable economic growth;*
- *Set criteria, or identify strategic sites, for local and inward investment to match the strategy and to meet anticipated requirements over the plan period;*
- *Support existing business sectors, taking account of whether they are expanding or contracting and, where possible, identify and plan for new or emerging sectors likely to locate in their area. Policies should be flexible enough to accommodate needs not anticipated in the plan and to allow a rapid response to changes in economic circumstances;*
- *Actively manage patterns of growth to make the fullest possible use of public transport, walking and cycling, and focus significant development in locations which are or can be made sustainable;*
- *Plan positively for the location, promotion and expansion of clusters or networks of knowledge driven, creative or high technology industries; and*
- *Identify priority areas for economic regeneration, infrastructure provision and environmental enhancement."*

7.6 There is also an emphasis on encouraging strong, vibrant and healthy communities by creating a good quality built environment, with accessible local services that reflect community needs and support well-being.

Regional Planning Policy

The London Plan 2011 (2011)

7.7 The London Plan 2011 (Ref. 7-2) was formally adopted in July 2011. It supersedes the London Plan 2008 (consolidated with alterations since 2004) (Ref. 7-3) as the new spatial development strategy for Greater London. The London Plan 2011 sets out an integrated social, economic and environmental framework for the future development of London to 2031. The context and nature of the NLE is relevant to a number of London Plan 2011 policies, including:

- Policy 2.10A, regarding Strategic Priorities for the Central Activities Zone (CAZ), states (page 54) that *"The Mayor will, and boroughs and other relevant strategic partners should: enhance the strategically vital linkages between CAZ and labour markets within and beyond London in line with objectives to secure sustainable development of the wider city region";*
- Policy 2.13, regarding Opportunity Areas and Intensification Areas, states (page 59) that "*Development proposals within opportunity areas and intensification areas should:*
  - *Seek to optimise residential and non-residential output and densities, provide necessary social and other infrastructure to sustain growth, and, where appropriate, contain a mix of uses;*
  - *Contribute towards meeting (or where appropriate, exceeding) the minimum guidelines for housing and/or indicative estimates for employment capacity set out in Annex 1, tested as appropriate through*

opportunity area planning frameworks and/or local development frameworks;

- *Realise scope for intensification associated with existing or proposed improvements in public transport accessibility, such as Crossrail, making better use of existing infrastructure and promote inclusive access including cycling and walking; and*
- *Support wider regeneration (including in particular improvements to environmental quality) and integrate development proposals to the surrounding areas especially areas for regeneration."*

- Policy 3.3, regarding Increasing Housing Supply states (page 81) that the Mayor will seek provision of "at least 33,400 homes across London annually, with the target being reviewed in 2015-16. The boroughs will be required to monitor housing capacity and provision, and identify new and existing housing proposal sites for inclusion in their Local Development Frameworks (LDFs)";
- Policy 6.1A (page 177), seeks to encourage the closer integration of transport and development by:
  - *"Encouraging patterns and nodes of development that reduce the need to travel by car; and*
  - *Seeking to improve the capacity and accessibility of public transport, walking and cycling capacity particularly in areas of greatest demand".*

7.8 The Plan sets out a forecast that London's population may increase by 14% to 8.82 million by 2031, with the boroughs of Wandsworth and Southwark both having above average growth rates (+18%) (recent estimates have concluded that the forecast population for 2011 was too low and as such these estimates are being revised upwards).

7.9 Of relevance to the VNEB OA, within which the NLE is partially located, the Plan acknowledges (page 272) that "there will be other transport infrastructure necessary to support the sustainable development of strategically important parts of London, particularly to enable the maximum contribution towards delivery of the strategy and policies in this Plan. One example is a proposal for the extension of the Northern Line to serve the Battersea area. This would be needed to realise the full potential of the Vauxhall, Nine Elms and Battersea Opportunity Area, delivering at least 10,000 new homes, 15,000 jobs and regeneration of Battersea Power Station [BPS]."

7.10 The London Plan sets out a public open space hierarchy that provides a benchmark for open space provision. Proposed Early Minor Alterations to the London Plan

7.11 The Mayor has published revised early minor alterations to the London Plan (Ref. 7-4). These are aimed at ensuring that the London Plan is fully consistent with the Government's NPPF. At present these do not have implications for socio-economics.

7.12 Table 7-1 presents this hierarchy.

Proposed Early Minor Alterations to the London Plan

7.13 The Mayor has published revised early minor alterations to the London Plan (Ref. 7-4). These are aimed at ensuring that the London Plan is fully consistent with the Government's NPPF. At present these do not have implications for socio-economics.

Table 7-1 Open Space Hierarchy in London

Open Space Categorisation	Site Guidelines (Hectares)	Distances from Homes to Open Spaces (km)
Regional Parks	400	3.2-8
Metropolitan Parks	60	3.2[1]
District Park	20	1.2[2]
Local Parks and Open Spaces	2	0.4
Small Open Spaces	<2	<0.4
Pocket Parks	<0.4	<0.4
Linear Open Spaces	Variable	Wherever feasible

Source: The London Plan, 2011 (Ref. 7-2); 1 The area is not considered to be deficient in Metropolitan Park provision if it is located within 4.8 km (15 min) by bus; 2 The area is not considered to be deficient in District Park provision if it is located within 3.2 km by bus, or 5.9 km (10 min) by train.

Mayor's Transport Strategy

7.14 The Mayor's Transport Strategy (MTS) sets out his transport vision for London and details how TfL and partners will deliver the plan over the next 20 years (Ref. 7-6). The preparation of the MTS began with a public consultation taking place in late 2009/early 2010. A Draft MTS was then approved by the Mayor and published in May 2010.

7.15 The six goals set out within the MTS are all of relevance to the NLE, with three being of particular relevance to socio-economics:

- To support economic development and population growth;
- To enhance the quality of life for all Londoners; and
- To Improve transport opportunities for all Londoners.

7.16 Regarding economic development and population growth, Policy 1, and its justification, stresses the requirement for the relevant stakeholders *"to develop London's transport system in order to accommodate sustainable population and employment growth"*, which it estimates will grow by around 1.25 million people and 750,000 jobs respectively through to 2031. Policy 5 discusses the specificity of this in relation to central London, stating that *"stakeholders will seek to ensure efficient and effective access for people and goods within central London through providing improved central London connectivity and appropriate capacity"*, with the VNEB OA being highlighted as an area of particular concern.

7.17 The MTS, through Policy 7, sets out the importance of encouraging mode shift towards public transport, walking and cycling to achieve desired economic

outcomes, setting a target improvement from 57% to 63% of these journeys to be made via these modes.

7.18 In its aim to enhance quality of life, the ability of transport to affect impacts on health is acknowledged in the MTS (Policy 17) along with the implications this has for the economy, through addressing indirect costs such as absenteeism and incapacity related unemployment.

7.19 To improve transport opportunities for London residents, the importance of improving accessibility is recognised in the MTS, with Policy 21 stating that the Mayor will seek to increase accessibility for all Londoners by promoting measures to improve the physical accessibility of the transport system, including streets, bus stops, stations and vehicles. In specific reference to supporting regeneration and tackling deprivation, Policy 22 of the MTS states that stakeholders will seek to *"reduce community severance, promote community safety, enhance the urban realm and improve access to jobs and services in deprived areas"*.

Vauxhall Nine Elms Battersea Opportunity Area Planning Framework

7.20 It is widely recognised that the key to achieving the potential of the VNEB OA is the provision of significant improvements to public transport accessibility (Ref. 7-5).

7.21 The OAPF has the following aspirations, relevant to the NLE:

- To create a new London quarter for the benefit of the whole community;
- To realise the optimum development potential of the area with 16,000 new homes and 20,000 – 25,000 new jobs;
- To deliver a step change in public transport provision including a two station extension of the Northern line from Kennington to Battersea with an intermediate station at Nine Elms, supported by a package of rail, bus, cycling, pedestrian and highway improvements; and
- To improve the north-south linkages across the River Thames.

Local Planning Policy

London Borough of Lambeth (LBL)

7.22 The LBL's LDF Core Strategy, adopted in January 2011 (Ref. 7-7), sets out a clear vision and policies regarding the spatial aspects of development in Lambeth. Relevant policies from these documents are discussed below.

Transport

7.23 Policy S4: "The Council will achieve the Core Strategy's objectives for transport by:

- *Contributing to a sustainable pattern of development in the borough, minimising the need to travel and reducing dependence on the private car;*
- *…Requiring development to be appropriate to the level of public transport accessibility and capacity in the area, or to contribute towards increasing public transport accessibility and capacity where this cannot be achieved through pooling of planning obligation contributions with Transport for London (TfL) or other agencies' transport project funding as appropriate."*

Employment

7.24 Policy S3: *"The Council will support local economic development, Lambeth's contribution to the central and wider London economy and a range of local business and job opportunities, by giving priority to a diverse range of economically beneficial uses in appropriate locations. The Council will achieve this by:*

- *…Supporting employment and training schemes to maximise local employment opportunities and help to address skills deficits in the local population."*

Open Space

7.25 Policy S5: "*The Council will meet requirements for open space by:*

- *Protecting and maintaining existing open spaces and their function;*
- *…Improving the quality of, and access to, existing open space, including the range of facilities available and its bio-diversity and nature conservation 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."*

Housing

- Policy S2: *"The provision of at least 7,700 net additional dwellings across the borough between 2010/11 and 2016/17 in line with London Plan targets, and a further 8,800 more homes by 2024/25 subject to London Plan targets for this period."*

London Borough of Wandsworth (LBW)

7.26 The LBW's Core Strategy and Development Control Polices Document, adopted in 2010 (Ref. 7-8), sets out a clear vision for the spatial aspects of development in Wandsworth. The following section presents the current position the Council takes on the themes relevant to the NLE.

Transport

7.27 Supporting large-scale investment in public transport is a key objective in the Core Strategy, primarily aimed at addressing existing capacity issues, with Policy PL3 stating that *"Improvements to public transport will be supported including enhanced capacity on rail and underground lines…"*.

7.28 For the VNEB OA, it is further noted within the Core Strategy that 'longer term improvements to public transport and other infrastructure can unlock the potential of the whole of the area, with opportunities for higher density development resulting in a further 8,500 homes and 185,000m^2 of employment floorspace".

Employment

7.29 Policy PL6 'Meeting the Needs of the Economy' sets out the key principles regarding the economy and employment in the Borough and states that *"c. The Nine Elms area will continue to be a significant employment area".*

Housing

7.30 Regarding the provision of new homes, Core Policy PL5 states that "*the Council will make provision for at least 7,500 net additional homes between 2007/08 and 2016/17 including at least….1,500 in the Vauxhall/Nine Elms/Battersea Opportunity Area' and '(the Council) will also seek to achieve a further 3,750 net additional homes in the Borough between 2017/18 and 2021/22".*

London Borough of Southwark (LBS)

7.31 The LBS's Core Strategy (Ref. 7-9), sets out a clear vision for the spatial aspects of development within the Borough. The Core Strategy document was adopted in April 2011 and supersedes the UDP 'Southwark Plan' aside from those 'saved' policies of the Plan (Ref. 7-10) which have not been replaced by the Core Strategy and which remain relevant for consideration. The following strategic policies of the LBS Core Strategy are relevant to the NLE:

Transport

7.32 Strategic Policy 2 states that the Borough "*will encourage walking, cycling and the use of public transport rather than travel by car. This will help create safe, attractive, vibrant and healthy places for people to live and work by reducing congestion, traffic and pollution".*

Employment

7.33 Strategic Policy 10 states that the borough "*will increase the number of jobs in Southwark and create an environment in which businesses can thrive. We will also try to ensure that local people and businesses benefit from opportunities which are generated from development."*

Housing

7.34 Strategic Policy 5, 'Providing new homes', outlines LBS strategy for *"providing high quality new homes in attractive environments"* and outlines an overall target of 24,450 homes within the Borough over the Core Strategy period (to 2026), outlining a residential density of 650-1,000 habitable rooms per hectare within the CAZ.

Assessment Methodology and Significance Criteria

Assessment Methodology

7.35 The following assessment seeks to establish the potential economic and social effects of the NLE and assess these against:

- Current baseline conditions; and
- Expected baseline conditions upon completion of the NLE as defined in *Chapter 2: EIA Methodology.*

7.36 The effects of the NLE are considered at varying spatial levels according to the nature of the impact considered (*Chapter 2: EIA Methodology*). This approach is consistent with English Partnerships Guidance 'Additionality Guide, A Standard Approach to Assessing the Additional Impact of Projects, 3rd Edition' (Ref. 7-11).

7.37 Wherever possible, 2011 Census (Ref. 7-12) data has been used. However, the phased release of this data means that some data contained within the assessment is drawn from the 2001 Census (Ref. 7-13).

7.38 The principal economic effect of the NLE is considered relative to Greater London, as this represents the principal labour market catchment area. The principal labour market is commonly known as the Travel to Work Area (TTWA) and can be derived by analysing 2001 Census data.[1] The LBL, LBW and LBS are accessible from all areas of Greater London, and are served by labour from all boroughs of this region. This labour market also incorporates the population that may reasonably be expected to travel to and benefit from the proposed development.

7.39 The NLE is located within the LBL, LBW and LBS. Where more local analysis is deemed relevant, conditions are assessed at 2011 Census (Ref. 7-12) Ward level. A 'study area' has been defined for this Chapter that includes the five wards most proximate to the proposed NLE, namely Bishop's, Prince's, Oval, and Stockwell (LBL) and Queenstown (LBW). Table 7-2 presents the different components of the assessment and the geographical scale at which they are assessed.

7.40 With regard to existing businesses, the assessment gives consideration to those that could be directly affected, i.e. displaced or lost, as a result of the NLE or indirectly affected to the extent to which their operations can no longer continue unimpeded.

7.41 With regard to open space and community facilities, the assessment gives consideration to those that will be directly affected, i.e. displaced or lost permanently or temporarily, as a result of the NLE. These are limited to the areas of Kennington Green and Kennington Park and the Kennington Park Lodge (within the landtake area in Kennington Park). There are no anticipated beneficial or adverse impacts on other community facilities expected as a result of either the construction or operation of the NLE.

7.42 With regard to transport, the assessment takes account of studies such as the 'Vauxhall Nine Elms Battersea Opportunity Area Transport Study' (2009) (Ref. 7-14) prepared external to this Application.

Table 7-2 Socio-economic Impacts by Geographical Scale

Impact	Geographical Area of Impact	Rationale for Impact Area
Employment generation during the construction phase (direct, indirect and induced impacts)	Greater London	Travel to Work Area, derived from 2001 Census
Employment generation during the operational phase (direct, indirect and induced impacts)	Greater London	Travel to Work Area, 2001 Census
Impact on accessibility to and utilisation of open space during the construction and operational phases	Radii of 400m from edge of open spaces	London Plan 2011

[1] The Office of National Statistics plans to prepare an update of Travel to Work Areas reflecting 2011 Census data, but this is not scheduled for release until November 2013.

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Impact	Geographical Area of Impact	Rationale for Impact Area
Impact on utilisation of open space during the construction and operational phases	Radii of 400m from edge of open spaces	London Plan 2011
Impact on existing businesses during the construction and operation phase	Limit of land to be acquired and used and immediate vicinity of construction sites	Extent of construction works operations
Impact on community facilities during the construction and operational phases	Within 1km	Typical walking distance
Impacts on development within the VNEB OA	VNEB OA	Development Infrastructure Funding Study Area
Impacts on labour market and productivity	VNEB OA and Greater London	Study area defined in *Chapter 6: Traffic and Transport*

Significance Criteria

7.43 The assessment uses the scale of significance described in *Chapter 2: EIA Methodology*. In this chapter, policy thresholds and current good practice are used to assess the scale of impacts and the significance of effects. However, in the absence of such guidance, expert judgement is used to assess the effect of the NLE on the social and economic baseline receptors.

7.44 Effects are defined as:

- Beneficial classifications of significance indicate an advantageous or beneficial effect on an impact area, which may be minor, moderate, or major in effect;
- Negligible classifications of significance indicate small or imperceptible effects on an impact area; and
- Adverse classifications of significance indicate a disadvantageous or adverse effect on an impact area, which may be minor, moderate or major in effect.

7.45 Temporary to short-term impacts are considered to be those associated with the construction works. Medium to long term impacts are those associated with the completed development.

7.46 The magnitude of an impact has been determined on the basis of its severity or scale. The magnitude of an impact reflects consideration of information and analysis relating (dependent on the type of receptor) variously to:

- Spatial extent of the impact (localised / isolated versus widespread with potential secondary impacts, having regard to published standards (where existing) on the geographical effect area / catchment area of the affected resource or receptor;
- Extent (number of users affected);
- Duration (temporary (less than 12 months), short term (one to five years) medium -term (over five years) and long term (permanent) impacts);
- Conformity with standards for provision or accessibility (as set out in regional or local planning guidance); and
- Permanency of the impact.

7.47 Based on consideration of the above, where a beneficial or adverse impact is assessed, significance has been assigned using the scale below:

- Minor;
- Moderate; and
- Major.

7.48 The complexity of interactions between these factors when impacting on socio-economic receptors means that it has not been considered appropriate to set out precise quantitative measures. However, the assessment process has ascertained information in respect of the above factors and professional judgement has been employed to evaluate the magnitude of the impact (high, medium or low).

Baseline Conditions

7.49 This section establishes the current baseline with regards to the following characteristics relevant to the NLE:

- Regional (London) economy and local economy;
- Industry;
- Existing demographic profile;
- Transport;
- Open space provision and quality;
- Existing businesses;
- A community facility (Kennington Park Lodge); and
- Expected (future) demographic profile.

7.50 Potential impacts arising from the NLE are assessed relative to the baseline impact areas set out in Table 7-2 and benchmarked against regional and national standards where appropriate.

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Economy

London

7.51 In 2012, 5.03 million people were employed in the Greater London area. The number is projected to increase to 5.11 million by 2014 (Ref. 7-15). According to the 2001 Census, 13% of the London workforce lives outside Greater London (Ref. 7-13). London's economy is driven by services. 92% of jobs are in the service sector. In 2008, employment in finance, IT and other business activities was significantly higher than the national average (34.7% for London, 22% for Great Britain) (Ref. 7-16). A breakdown of broad employment sectors is presented in Table 7-3.

Table 7-3 Employee Jobs 2008

	LBL (%)	LBW (%)	LBS (%)	Greater London (%)	Great Britain (%)
Manufacturing	2.0	3.0	4.8	4.3	10.2
Construction	2.4	3.6	3.5	2.9	4.8
Services	95.1	93.3	91.2	92.4	83.5
Distribution, Hotels & Restaurants	18.2	24.3	13.5	21.0	23.4
Transport and Communications	4.8	6.5	5.2	7.4	5.8
Finance, IT, other Businesses Activities	27.9	24.0	43.1	34.7	22.0
Public Administration, Education & Health	34.8	31.0	22.0	22.2	5.3
Other Services	9.5	7.5	7.4	7.2	8.2

*Source: ONS Annual Business Inquiry Employee Analysis (2012) (Ref. 7-16) *For reasons given by the ONS, the columns in this table do not add up to 100%. This is due to the fact that the tourism-related category consists of industries that are also part of the services industry and also that employee jobs exclude self-employed, government-supported trainees and HM Forces.*

Local - London Boroughs of Lambeth, Wandsworth and Southwark

7.52 Table 7-3 presents the breakdown of employment sectors for the LBL, LBW and LBS. Employment in transport and communications is proportionately lower in these boroughs than for London as a whole. Public Administration, Education & Health is the largest sector by employment in both the LBL and the LBW, with Finance, IT and other business activities forming the lead employment sector in the LBS.

7.53 In November 2008, it was estimated that the VNEB OA accommodated 26,380 jobs, with a roughly even split between those found in the LBL and the LBW (Ref. 7-14). Employment land uses currently in the OA include industry, logistics, office and retail uses.

7.54 The logistics uses in the OA are located on Nine Elms Lane, to the north and west of the New Covent Garden market in the centre of Nine Elms and the Flower Market site to the west of Vauxhall. There are a range of office and warehouse uses on Albert Embankment and at Vauxhall, and a large Sainsbury's supermarket located on Wandsworth Road.

7.55 Recently, following the removal of the OA's former Strategic Industrial Location (SIL) designation, new developments have been consented (with some already under construction) which are changing the character of the OA from an industrial employment area towards what will become a mixed-use residential and services orientated employment area (see later for more details).

Industry

7.56 In 2010 there were estimated to be 144,400 private sector construction workers in Greater London (Ref. 7-17). The Construction Skills Network forecasted, in 2011, that in order to meet the demand created by the industry, the total number of construction workers in Greater London (including architectural and professional services) would, by 2016, increase by 6% on the projected level for 2012 (Ref. 7-18).

7.57 Table 7-4 presents a detailed breakdown of employment sectors by borough and shows that the proportionate level of construction employment in Greater London is higher than in each of the LBL, the LBW or the LBS (Ref. 7-19). Nationally, gross construction output in the railways sector stood at £2.6 billion in 2010, the highest figure recorded since comparable records began in 2007 and significantly higher than the £0.9 billion recorded in 2005 (Ref. 7-17).

Existing Demographic Profile

Population

7.58 Table 7-5 presents population change between 2001 Census and Census 2011 data (Ref. 7-13 and Ref. 7-12) in the LBL, the LBW, and the LBS compared to Greater London. The rates of change indicate that population growth in the three boroughs most proximate to the NLE have experienced either stronger or equal growth over the time period when compared with the wider London average.

Table 7-4 Employee Jobs 2011

	LBL (%)	LBW (%)	LBS (%)	Greater London (%)	Great Britain (%)
Agriculture, forestry & fishing	0	0	0	1	0
Mining, quarrying & utilities	2	1	1	1	1
Manufacturing	1	1	2	9	2
Construction	3	3	4	5	3
Motor trades	0	0	1	2	1
Wholesale	2	2	4	4	3
Retail	6	5	11	10	9

	LBL (%)	LBW (%)	LBS (%)	Greater London (%)	Great Britain (%)
Transport & storage (inc postal)	4	4	4	5	5
Accommodation & food services	8	5	8	7	7
Information & communication	9	9	6	4	8
Financial & insurance	1	5	2	4	8
Property	1	1	3	2	2
Professional, scientific & technical	7	19	9	7	12
Business administration & support services	15	13	8	8	10
Public administration & defence	7	7	5	5	5
Education	7	9	10	9	8
Health	20	11	18	13	10
Arts, entertainment, recreation & other services	6	5	6	5	5

Source: ONS Business Register and Employment Survey (2011) (Ref. 7-19).

Table 7-5 Population Change 2001 - 2011

	LBL	LBW	LBS	Greater London
2001 Census	266,169	260,380	244,866	7,172,091
2011 Census	303,086	306,995	288,283	8,173,941
% Change 2001 - 2011	14	18	18	14

Source: ONS 2001 Census (Ref. 7-13) and 2011 Census (Ref. 7-12)

7.59 In 2011, the Census recorded that 70,151 people lived in the identified five-ward Study Area (Ref. 7-12).

Employment

7.60 Ward-level data for unemployment is available from the 2011 Census. As shown in Table 7-6 below, at that time, there were 3,153 unemployed people within the five-ward Study Area, equivalent to 6% of the population aged 16-74 years old. This is compared to 3,085 people recorded in 2001 (Ref. 7-13).

7.61 In February 2013, there were approximately 2,500 Job Seeker's Allowance (JSA) benefit claimants in the five ward Study Area (Ref 7:30).

Table 7-6 Ward Level Unemployment (2011)

	Bishop's	Prince's	Oval	Stockwell	Queenstown	Total
Actual	403	664	599	823	664	3,153
% of Population unemployed aged 16-74	5	6	5	7	5	6

Source: Census 2011 (Ref. 7-12)

Qualifications, Skills and Deprivation

7.62 In 2011, residents of the Study Area had lower qualifications levels than the regional average, with 47% of working age residents holding an NVQ4+ qualification compared with 38% in London. Approximately 14% of the population in the Study Area held no qualification, compared to a London figure of 18% (Ref. 7-12).

7.63 According to the Index of Multiple Deprivation 2010, the LBL is the 5th most deprived of the 32 London Boroughs[2] (Ref. 7-21), with LBW ranking 22nd. Of the five wards within the Study Area, Prince is ranked as the most deprived overall, with Queenstown being the least deprived. The five wards all ranked in the top 40% of deprived wards in London.

Transport

7.64 A full description of the transport baseline is provided in *Chapter 6: Traffic and Transport.*

Public Transport Infrastructure

7.65 Based on the findings of the VNEB OA Transport Study (Ref. 7-14), parts of the study area are well served by public transport infrastructure with this being concentrated in the north east and west of the area. The Vauxhall National Rail/Underground/Bus station constitutes the main hub within the OA itself, with improvements having been made to this node in recent years. Vauxhall station serves an important local function in terms of connecting local residents to jobs, goods and services. The Victoria line provides accessibility to the Underground network but is considered to be close to capacity in the morning and evening peak periods. The western part of the OA contains fewer public transport options, being limited to Queenstown Road and Battersea Park stations, and local bus services.

Public Transport Accessibility Level (PTALs)

7.66 PTALs give an indication of the relative density of the public transport network at a specific location. Results are expressed on a scale of 1 to 6 (including sub-divisions 1a, 1b, 6a and 6b) where 1a indicates extremely poor accessibility to the location by public transport and 6b indicates excellent access. Areas with high PTALs will generally considered to provide better access to employment and employment opportunities than those with lower levels.

[2] Not including the Corporation of London

7.67 The majority of the western and central parts of the OA, which the proposed stations would serve, have a low PTAL rating of 1 and 2 (Ref. 7-5) with Level 6 only found at the eastern end of the OA around Vauxhall.

7.68 The current and future baseline PTAL levels for the area are shown in Figures 6-9 and 6-10 of *Chapter 6: Traffic and Transport*. It is apparent from these figures that in both scenarios the north and east of the OA is the best served by public transport with little change in accessibility in either the south or west.

Open Space Provision and Quality

7.69 Of the surface development sites associated with the proposed NLE, two are located within areas of publicly accessible open space:

- Kennington Green Ventilation and Intervention Shaft – within Kennington Green; and
- Kennington Park Ventilation and Intervention Shaft – within Kennington Park.

7.70 Both these spaces are located within the Oval ward of the LBL. Qualitative surveys of these open spaces were undertaken as part of the 2004 Lambeth Open Space Strategy (OSS) with a further 'update' being undertaken in 2007 (Ref. 7-23, Ref. 7-22 and Ref. 7-24). Neither of these studies assessed usage levels of the open spaces in Lambeth. Further details regarding each of these spaces are provided below. Details of the ecology, heritage, archaeology, townscape and ground conditions are provided in the relevant chapters of this ES.

Kennington Green

7.71 Kennington Green, is an area of open space as defined in the Acquisition of Land Act, 1981, and is identified in the LBL OSS as being a 'Green/ Common' of 0.09ha (900m^2) in size, or a 'pocket park' if assessed against the GLA hierarchy. The London Squares Preservation Act 1931 is also a relevant material planning consideration and seeks to limits the use of London Squares to 'ornamental pleasure grounds or grounds for play, rest and recreation', and the only building and structures allowed are those which are 'necessary or convenient for, and in connection with, the use and maintenance of such squares.'.

7.72 The LBL OSS assessed that the space had a quality score of 46%, which is roughly equal to the average score for all unrestricted open spaces in LBL (47%). It was not surveyed in the 2007 OSS Update.

7.73 The nearest parks or open space providing comparable (or better) amenity to Kennington Green are Kennington Park, located approximately 190m away (and described below) and Spring Gardens, approximately 550m away.

Kennington Park

7.74 Kennington Park, a registered park under the Historic Buildings and Ancient Monuments Act 1953 is identified in the LBL OSS as being a 'Major Park' of 15.5ha in size (including the park's extension to the east of St Agnes Place), falling within the GLA hierarchy's 'local park' classification. It should be noted that the land occupied by Kennington Park Lodge and the associated community building is not an area of open space as defined in the Acquisition of Land Act, 1981.

7.75 In the 2004 LBL OSS, it achieved a quality score of 56%. In the 2007 OSS Update, it achieved an improved score of 66%, which ranks it as the 4th highest scoring open space in the borough. Improvements made to the park in the intervening period, identified in the OSS Update include:

- Replacement of benches and bins, refurbishment and repair of footpaths;
- New entrance signage at seven locations;
- Refurbishment of the Prince Consort's Model Lodge, clearing and renovation of the lodge garden;
- Installation of new multi use games area on site of old playground; refurbishment of old tennis courts;
- Renovation of old toilets, including conversion to female/children's toilet linked to relocated play area; and
- Restoration of old Walled Garden and shelter.

7.76 The park contains areas for dog walking including a fenced at the location of the proposed ventilation and intervention shaft.

7.77 The nearest park or open space, providing comparable amenity to Kennington Park, is Vauxhall Park located approximately 700m away, with the larger Burgess Park being located approximately 800m to the east.

Existing Businesses

7.78 The proposed works at the Kennington Green worksite and the proposed Nine Elms and Battersea station sites are located in proximity to businesses.

7.79 At Kennington Green, some of the proposed works would take place within the Beefeater Gin Distillery on land currently owned by the occupant.

7.80 At the proposed Nine Elms station, the proposed works would displace commercial premises occupied by Banham Security Ltd, and Covent House, the head office and boiler house of the Covent Garden Market Authority (CGMA). In the construction period it would potentially, were planning permission for it to be consented, also be on/adjacent to a temporary Sainsbury's supermarket store on Wandsworth Road, built to help facilitate the redevelopment of their existing store. In addition to this, the proposed construction of a pedestrian route beneath the existing railway arches to the north may fully or partially displace current market traders from the arches (notably Tropical Catering).

7.81 At the proposed Battersea station site, proposed works would be located close to commercial office premises at Brooks Court on Kirtling Street, and industrial properties (a cement works and waste transfer station) on Cringle Street.

7.82 A not for profit business Battersea Dogs and Cats Home (BDCH) is located adjacent to the Battersea station site and will be subject to some disruption during construction. Certain operations of the BDCH will require relocation during construction of the NLE; however, they will continue to be able to operate.

Community Facility (Kennington Park Lodge)

7.83 There is a community facility in the northwest corner of Kennington Park known as Kennington Park Lodge in this ES. This is owned by LBL and is used by a number of not for profit organisations including Bee Urban. The lodge is currently occupied

by Bee Urban who use the internal and external facilities for bee keeping and other activities There are no other known beekeeping facilities within typical walking distance (1km), though it is understood that the beekeepers use of the lodge itself are limited storage of equipment and use of domestic facilities.

Expected (Future) Demographic Profile

7.84 There are forecast to be an additional 18,635 new homes in the OA by 2031. The OA would also accommodate approximately 23,845 new jobs as set out in Table 7-9.

Potential Effects and Mitigation Measures

7.85 This section analyses the scale, permanence (short, medium, long-term), and magnitude of socio-economic impacts relative to the baseline established in the previous section. The following impacts are assessed:

- Direct, indirect and induced employment of the NLE during its construction and operation phases;
- Access to employment;
- Impact on open space users during construction and operation phases;
- Impacts on existing businesses;
- A community facility (at Kennington Park Lodge); and
- Broader socio-economic impacts of the NLE.

Construction Phase

Construction Employment

7.86 There are two distinct construction options for the NLE (described in *Chapter 4: Description of the NLE*) however, for the purpose of the socio-economic assessment, the two options have been considered has requiring the same amount of construction labour.

7.87 It is estimated that the NLE could require an average of 609 direct construction jobs per annum. This estimate is based on professional judgement which has been applied to the proposed construction works to estimate the number of jobs required for the construction of the tunnel and station infrastructure.

7.88 It is considered that the type of works undertaken are such that there will be little or no displacement of construction workers. However, several other factors have been considered to estimate the indirect jobs generated by the NLE which are:

Leakage

7.89 Leakage effects are the benefits to those outside the impact area (Greater London). There is a high demand for skilled construction workers in the Greater London area. Analysis carried out on the 2001 Census data indicated that 13% of people working in Greater London live outside the area (Ref. 7-13). This corresponds to a low leakage as set out by English Partnerships Guidance (Ref. 7-11), and implies that the majority of employment opportunities will go to people living within the target area. A 13% discount is therefore applied to the estimated average of 609 direct jobs per year created by the construction phase although it is acknowledged that for the construction sector specifically, leakage could potentially be lower. It is thus estimated that 79 persons from outside Greater London and 530 persons from Greater London would be working at the proposed development per annum during the construction period.

Multiplier Effect

7.90 In addition to the direct construction employment generated by the project itself there will be an increase in local employment arising from indirect and induced effects of the construction activity. Employment growth will arise locally through manufacturing services and suppliers to the construction process (indirect or supply linkage multipliers). Additionally, part of the income of the construction workers and suppliers will be spent in Greater London, generating further employment (induced or income multipliers).

7.91 The impact of the multiplier depends on the size of the geographical area that is being considered, the local supply linkages and income leakage from the area. English Partnerships Additionality Guide (Ref. 7-11) provides a ‘ready reckoner’ of composite multipliers – the combined effect of indirect and induced multipliers. Greater London is likely to have ‘strong’ supply linkages based on the scale of its economy. Therefore a multiplier of 1.7 is determined from the English Partnerships guidance to be the most appropriate measure of multiplier effects.

Total Net Employment

7.92 Table 7-7 presents the temporary employment created by the NLE taking leakage, and multiplier effects into account. The total net additional employment arising from the NLE is estimated to be an average of 901 jobs within Greater London and overall an average of 1,035 jobs per annum in total.

Table 7-7 Estimated Net Construction Employment

	Greater London	Outside of Greater London	Total
Direct Employment	530	79	609
Indirect Employment (with 1.7 multiplier)	371	55	426
Total Net Employment	**901**	**134**	**1,035**

Source: URS Calculations 2013. Note that figures do not always add up due to rounding.

7.93 The magnitude of the above impact is influenced by the following factors:

- Given the length of the construction phase (approximately six years) a portion of the jobs created would be for the duration of the construction works. Therefore they would provide short term employment opportunities for workers.
- The scale of the direct employment generated by 1,035 net new construction jobs represents around 0.7% of the total 144,400 jobs in the construction industry.

7.94 On the basis of the above factors, overall, it is considered that employment generation during the construction phase of the NLE would represent a minor beneficial medium term impact on the Greater London economy.

7.95 The NLE will aspire to meet the requirements set out by the Nine Elms Vauxhall Employment, Training and Business Charter (Ref. 7-25), which includes pledges to:

- Generate job, apprenticeship and training opportunities targeted towards local residents in Wandsworth and Lambeth;
- Focus opportunities towards unemployment people across the two boroughs;
- Work with local schools and colleges to provide students with workplace experience and career taster sessions;
- To work together and share resources to recruit, train and develop candidates from entry level and above; and
- Make local businesses aware of contract opportunities and help local firms develop the skills required for competitive tendering.

7.96 TfL will also seek to secure contractors and suppliers to the project via 'responsible procurement' as is defined and set out in the GLA's 'Delivering Responsible Procurement' programme (Ref. 7-26), which is designed to respond to relevant European and UK Government legislation and best practice. A key focus of TfL procurement operations has been on embracing supplier diversity and ensuring engagement with small and medium enterprises (SMEs), with the latter being encouraged and supported by TfL during the ongoing economic downturn.

7.97 This focus harmonises with the Mayor's 'Equal Life Chances for All' framework (Ref. 7-27), which is aimed at *"delivering concrete, sustainable improvements for the city, and reducing the impact of the economic downturn on the most vulnerable, disadvantaged, and newly arrived communities"*.

Open Space

7.98 For the duration of construction works at the Kennington Green and Kennington Park worksites there would be a temporary loss of public access to 900m^2 of open space, comprising 100% of the total area of Kennington Green and approximately 2500m^2 (2% of the total area) of Kennington Park.

7.99 The duration of the construction works at these sites is classified as being a medium term effect, lasting for approximately 3 years and 2 months at Kennington Green and 3 years and 9 months at Kennington Park.

7.100 It is considered that existing users of Kennington Green 'pocket park/small open space' would not be significantly affected by this temporary loss and there is access to alternative areas of nearby open spaces, such as Kennington Park itself and Vauxhall Gardens.

7.101 Kennington Park, of 'local park' size is within 400m of both spaces and thus provides an open space large enough that any park users can still make use of it whilst being at a far enough distance from the proposed works area. The temporary closure of the spaces could result in some residential properties being more than 400m from an open space for the medium term duration of the construction activities.

7.102 Although the park is assumed to be well used, the number of users likely to be impacted by a short-term temporary closure of the affected area of open space is judged to be relatively few given its small size and position relative to the rest of the park. The majority of the affected space is a fenced off area with use restricted to dog walkers. This means that most users would be likely to be making use of the areas outside the affected space. As such, they would not be likely to experience significant disruption as a result of the construction works. LBL have agreed to work with TfL to provide replacement dog walking facilities, subject to these costs being covered by TfL. This would minimise impacts on users of the affected space.

7.103 In conclusion, overall, it is assessed that the NLE would have a minor adverse medium term impact on open space provision in the local area during the construction phase.

Impact on Existing Businesses – Banham Security Ltd, CGMA, Tropical Catering, Sainsbury's and BDCH

7.104 The construction works would require the use of land and thus displacement of Banham Security Ltd and Covent House, the head office of CGMA. These occupiers would require new premises to operate from the commencement of construction works. It is assumed that Banham Security Ltd would seek to relocate to an alternative location and that CGMA would seek to relocate their head office function to an alternative/ temporary location within the wider CGMA site. A proportion of operational parking/ delivery vehicle space on the main CGMA site could be temporarily lost as a result of the space required for construction.

7.105 The proposed pedestrian connection through the railway viaduct will lead to the relocation of one existing business (Tropical Catering). TfL would work with CGMA to ensure that suitable replacement premises can be found before the works are commenced. The most likely option is that the business would be a relocation site within the existing CGMA site, located to the north of the construction worksite.

7.106 The TWAO also includes powers to undertake protective works to the railway viaduct. These powers would only be exercised if the effect of settlement caused by the construction of NLE proves that such is necessary. These protective works powers would lead to the temporary relocation of up to nine businesses during the period such works are undertaken. It is expected that protective works would not take longer than 12 months, so would be a short-term effect. Again TfL would work with CGMA to ensure that suitable replacement premises can be found before the works are commenced.

7.107 During the construction of the Nine Elms station box, the associated construction works and vehicles have the potential to disrupt access and parking of the CGMA site. TfL will manage construction works so as to minimise any disruption as much as practicable to ensure that the effects on CGMA during construction will be negligible.

7.108 Works would also require the use of land currently within the ownership of Sainsbury's Supermarket Ltd (SSL) and currently used as store car parking and a petrol filing station. It is assumed that these uses will be removed prior to the commencement of construction as part of the wider redevelopment programme being pursued by SSL. There is a proposal to provide a 'temporary store' on this area of land (subject to planning consent). This temporary store may need to be removed prematurely to allow NLE construction works to commence.

7.109 At the Battersea station site, works would require use of land within the BDCH site in order to construct the overrun tunnels.

7.110 Overall the impact on displaced and affected businesses is considered to be moderate adverse before mitigation.

7.111 To reduce any adverse effect, TfL is working closely with affected landowners to minimise the impact of the NLE works on their business. This includes discussions around potential relocation and phasing of the NLE works to minimise impacts on their business operations. Any compensation will be agreed in accordance with the statutory compensation code. Overall, taking into account these measures, the impact on these displaced and affected businesses has been assessed to be minor adverse medium term.

Impact on Existing Businesses – Beefeater Gin Distillery

7.112 The NLE construction works would require permanent land take for siting the Kennington Green head house on land forming part of the Beefeater Gin Distillery. Construction of the head house would require the temporary possession of part of the distillery's yard area, temporary reconfiguration of the vehicular and pedestrian access arrangements from Kennington Green and the provision of certain mitigation measures to ensure the safe coexistence of the head house building and its plant/equipment alongside the adjacent ethanol discharge facilities. In addition, because the head house would displace a proposed fire suppressant water storage tank required by the distillery's insurers, provision is being made for the tank to be located on adjacent land to the north owned by Tesco. With these mitigation measures in place, it is anticipated that effects on the distillery's operations and underlying business will be negligible.

Community Facility

7.113 Kennington Park Lodge would be demolished as a result of the NLE. This would result in the occupiers being displaced for the duration of the works at this site (approximately 3 years and 11 months based on Construction Option A).

7.114 To mitigate this, replacement facilities for the occupiers are proposed located to the west of the worksite, within Kennington Park and would be in place before the demolition of the existing facility and is anticipated to be available for the duration of the works. The illustrative location of these buildings are shown in Figure 4-10 in *Chapter 4* : *Description of the NLE.* There would also be opportunity for the occupiers to return to suitable replacement facilities provided within the building.

7.115 It is therefore assessed, overall, that the NLE would have a negligible impact on these occupiers.

Operational Phase

Operational Employment

7.116 Table 7-8 provides a breakdown of jobs created by the operational phase of the NLE. Taken together, it is estimated that the NLE will create 79 direct full time equivalent (FTE) jobs once in operation.

7.117 Assuming a leakage of 13% outside Greater London and a 1.7 multiplier, it is estimated that the total net employment associated with the NLE will be 134 employees, of which 117 will be from the Greater London area. This is presented in Table 7-9.

Table 7-8 Employment Generation of the NLE in Operation

Role	Employment (employees)
Train operation	30
Station staffing (both stations)	29
Maintenance	20
Total	79

Source: Information provided by TfL

Table 7-9 Total Net Employment Created During the Operational Phase of the NLE

	Employees		
	Greater London	**Outside Greater London**	**Total**
Direct Employment	69	10	79
Indirect Employment (with 1.7 multiplier)	48	7	55
Total Net Employment	**117**	**17**	**134**

Source: URS Calculations 2013. Note that figures do not always add up due to rounding.

7.118 The magnitude of the impact is influenced by the following factors:

- The employment created would be permanent and long term in nature, as there will be an ongoing requirement for these jobs throughout the NLE's operational lifespan; and
- The number of jobs created within the context of the Greater London labour market is relatively small.

7.119 On the basis of the above factors overall it is considered that direct employment generation during the operational phase of the NLE would represent a minor beneficial long-term impact on the Greater London economy. See paras 7.95 and 7.96 for information on procurement related to employment.

Open Space

7.120 The affected areas of open space would be reinstated as soon as practically possible following completion of the construction works. The proposals do not result in the permanent loss of open space and the proposed landscape works to reinstate the land are expected to lead to improvements in quality. The TWAO includes powers that will allow TfL to acquire compulsorily permanent proprietary rights over this open space to allow for occasional maintenance and repair works associated with the NLE. The frequency of access is anticipated to be very limited and to cater for two occasions. First, in the (unusual) event that the structures' water proofing should fail, which would require short term access to allow repair works and secondly, once the operational life of the structures has come to an end, usually after 125 years, access may be required whilst the structures are removed and replaced. The effect of these access rights has been taken into account in this

assessment and they are considered to have no significant effect on the provision and use of the open spaces concerned during the operational phase. Accordingly, TfL has applied to the Secretary of State for Communities and Local Government for a certificate to that effect under Schedule 3 to the Acquisition of Land Act 1981 in relation to the relevant areas of open space and the Secretary of State has in response required TfL to give public notice of his intention to give such a certificate, so triggering the formal representations process under that Act concurrently with the Transport and Works Act representations process.

7.121 In terms of quality, at Kennington Green, the proposed landscape strategy seeks to enhance the site's unique identity and to provide an attractive setting for the surrounding residential buildings.

7.122 At Kennington Park, the key aims of the soft landscaping strategy are to reinforce the existing character of the park and enhance the site's ecology and biodiversity (see *Chapter 14: Ecology* and the Design and Access Statement *(ES Volume II: Appendix M)* for more details). It is assessed therefore that the NLE will have a minor beneficial long term impact on open space provision in the local area during the operational phase.

Community Facility (Kennington Park lodge)

7.123 The NLE would result in a rebuilt lodge providing a new-build facility. The rebuilt lodge would be at least as good as is currently provided.

7.124 It is therefore assessed that the NLE will have a minor beneficial long term impact on the provision of community facilities within the local area.

Impacts on Wider Development

7.125 The assessment of the NLE is based on a number of assumptions regarding the level of development which will come forward within the VNEB OA. These assumptions vary on the basis of the implementation of the NLE which can be considered as 'With or Without the NLE' development scenarios.

7.126 The 'Without Scenario', assumes all of the consented schemes (as set out in the cumulative assessment) within VNEB are built out according to their planning consents as of January 2013, with the exception of specific phases of the BPS development. BPS includes a Grampian Condition which means that only RS-1 and the residential areas within the Power Station can be built prior to the implementation of the NLE. The remaining phases of the development therefore cannot come forward under the current consent without the NLE. The number of homes and estimated population and jobs expected under this scenario are set out in Table 7-10.

7.127 The 'With NLE'scenario assumes that all consented schemes are constructed as per their planning consents in January 2013 (including all phases of BPS), and also includes other sites within VNEB which have yet to come forward with a planning application. A number of these sites are currently in pre-application stage. Development assumptions have been made for these sites by applying similar development densities that have been consented on other sites of similar size and location to estimate the number of homes and commercial floorspace which could come forward. The likely population and employment generated were estimated using the same assumptions as used on the consented schemes.

7.128 The number of homes and estimated population and jobs expected under these 'With NLE' and 'Without NLE' scenarios are set out in Table 7-10.

7.129 Defined in this way, the NLE is the catalyst for delivering up to 5,500 additional units and 14,000 additional jobs in the OA compared to what would happen if the NLE was not built. This is a significant share of the London Plan targets and of the boroughs' housing targets. In LBW's case, VNEB is critical to delivering its housing target. This therefore represents a long-term major beneficial impact.

7.130 However, the beneficial impact is likely to be wider felt than this. The fact that there are no planning conditions preventing some development without the NLE does not mean that without the NLE, all the consented developments would be built, or that if they were they would supported by sustainable travel patterns.

Table 7-10 Development Scenarios

Scenario	Description	Residential Units	Population	Gross Employment	Net Additional Employment
Without NLE					
	All consented development by January 2013 excluding the BPS phases which include a Grampian Condition which limit development to the implementation of the NLE	12,778	22,647	15,215	9,822
With NLE					
	All consented development plus remaining sites yet to come forward	18,365	34,366	29,238	23,845

7.131 The GLA, TfL, LBL and LBW together commissioned the Development Infrastructure Funding Study (Ref. 7-28). This considered what infrastructure would be required to support the delivery of 16,000 homes and 500,000 sqm of commercial and other non-residential floorspace. It concludes that, *"The large amount of high density development will necessitate the provision of a high capacity transport system for the OA."* The Study also states that, *"If office development is to succeed in the OA, it must become part of the Central London office market"* and for VNEB to attract enough office employment to create critical mass, the NLE (supported by a wider package of transport investment) was *"essential"* to enable the area to become an office location in its own right.

7.132 The NLE is therefore required both to provide transport capacity and to provide the accessibility required for the area to function as part of the CAZ and so attract occupiers. Without it, it has been estimated that only 8,500 homes and 8,000 jobs could be delivered sustainably (Ref. 7-28). The impact of the NLE is therefore likely

to be wider than that set out above, but remains a major beneficial long term impact.

Labour Market and Productivity Impacts

7.133 The improved connectivity to the rest of the CAZ will also have labour market and productivity impacts. Figure 6-16 in *Chapter 6: Traffic and Transport* illustrates the projected PTAL of the OA were the NLE to be realised. It can be seen that accessibility to the south and west of the OA is improved to a similar level to that currently experienced in the north and east (which themselves experience an increase through the building of the NLE alongside other improvements).

7.134 As described in *Chapter 6: Traffic and Transport*, it is forecast that the NLE will provide significant improvements in journey times between the Nine Elms and Battersea portions of the OA and other parts of London. These travel times vary by destination and distance travelled but will generally result in time savings of at least 20%, and as high as 65%, to and from other areas of the CAZ (Ref. 7-14).

7.135 This means more jobs will be accessible within a given travel time for existing residents of the local area, which can in turn mean they move to more productive jobs. Similarly, greater accessibility to all parts of central London increases the density of employment in an area which is also associated with higher productivity (Ref. 7-28).

7.136 There will also be benefits for local unemployed or economically inactive residents. Approximately 43% of the 237,000 jobs in LBL and LBW are filled by residents of those boroughs. Applying this to the additional 14,000 jobs set out above, would mean an extra 6,020 local residents working in the borough. A proportion of those would be previously unemployed or economically inactive, but it is not possible to estimate precisely how many. This therefore represents a major beneficial long term impact.

Impact on Existing Businesses

7.137 Additional footfall and demand created by the NLE and wider development within the OA would also be beneficial to existing business in the areas around and adjacent to the Battersea and Nine Elms stations.

Residual Effects Assessment and Conclusion

7.138 This chapter has analysed the magnitude of socio-economic impact of the NLE compared to baseline conditions. Table 7-11 lists the resulting effects according to the significance criteria outlined earlier in this chapter (and in *Chapter 2: EIA Methodology)*. In summary, it is considered that the NLE would have an overall **major beneficial** economic effect on the economy of the VNEB OA as well as Greater London as a whole, through:

- Direct and indirect employment generation;
- Improving access to employment opportunities for residents; and
- Improving connectivity between employment areas.

7.139 As the socio-economic impacts identified in this chapter are generally beneficial, there is no requirement to mitigate them. However, in the case of the adverse impact from the temporary loss of open space, efforts to mitigate this will be through the later provision of improved quality of open space set out in the Design and Access Statement (see *ES Volume II: Appendix M*).

7.140 At a local level, the NLE would have a long term positive effect on the provision of open space and community space in the local area.

Table 7-11 Assessment of Residual Effects

Aspect	Significance	Explanation
Construction Phase		
Employment creation	**Minor Beneficial – medium term**	There would be an estimated direct construction employment of 609 full time jobs, and net employment of 1,034, arising from the induced and indirect impacts of the activities. Of the 1,034 net jobs 901 are likely to be taken up by workers from the Greater London area. Jobs would be medium term.
Open Space	**Minor Adverse – medium term**	At two locations, areas of open space would be temporarily cordoned off and closed for public access for 3 years and 2 months and 3 years 9 months respectively
Existing Businesses – Banham Security Ltd, Tropical Catering, CGMA, Sainsbury's and BDCH	**Minor Adverse – medium term**	These businesses would be displaced or otherwise disrupted as a result of the construction works. To reduce any adverse effect, TfL is working closely with affected landowners to minimise the impact of the NLE works on their business. This includes discussions around potential relocation and phasing of the NLE works to minimise impacts on their business operations. Any compensation will be agreed in accordance with the statutory compensation code.
Existing Businesses – Beefeater Gin Distillery	**Negligible**	Construction would require the temporary possession of part of the distillery's yard area, temporary reconfiguration of the vehicular and pedestrian access arrangements from Kennington Green and the provision of certain mitigation measures. With mitigation measures in place, it is anticipated that effects on the distillery's operations and underlying business will be negligible.
Community Facility (Kennington Park	**Negligible**	Kennington Park lodge would be demolished as a result of the NLE. This would result in the occupiers being

Aspect	Significance	Explanation
lodge)		displaced for approximately the 3 years and 11 month duration of the works. The occupiers would be housed in alternative facilities and there would be opportunity for the occupiers to return to larger facilities
Operational Phase		
Employment creation	**Minor Beneficial – long term**	There will be an estimated direct employment of 79 full time jobs, and net employment of 134, arising from induced and indirect impacts. Of the 134 net jobs 117 are likely to be taken up by workers from the Greater London area. Jobs would be long-term.
Open Space	**Minor Beneficial – long term**	The open spaces would be reinstated in the operational phase to a greater standard of design quality than currently
Community Facility (Kennington Park lodge)	**Minor Beneficial – long term**	The NLE would result in a rebuilt lodge providing a new-build facility, improving its value as a community resource, and for use by either the previous occupiers, should they choose to return, or the local community if otherwise.
Impacts on Wider Development	**Major Beneficial – long term**	The NLE is the catalyst for delivering up to 5,500 additional units and 14,000 additional jobs in the OA compared to what would happen if the NLE was not built. This is a significant share of the London Plan targets and of the Boroughs' housing targets. In LBW's case, VNEB is critical to delivering its housing target.
Labour Market and Productivity Impacts	**Major Beneficial – long term**	More jobs will be accessible within a given travel time for existing residents of the local area, which can in turn mean they move to more productive jobs. Shorter travel times increases the density of employment in an area which is also associated with higher productivity. There will also be benefits for local unemployed or economically inactive residents.

Cumulative Effects Assessment

7.141 The NLE has been assessed in the context of other proposed or consented developments in proximity to the site. The scenario which has been considered within the cumulative assessment comprises the developments as outlined within *Chapter 2: EIA Methodology* being constructed.

7.142 If all the schemes are to be realised there will be substantial new commercial, retail, and leisure space created that will help meet the needs of the new population and surrounding neighbourhoods. The new employment space will provide considerable job opportunities for existing residents and a number of new residential and commercial units (providing a considerable number of new homes and jobs) will be delivered.

7.143 In addition to the direct impacts set out, the NLE will have a series of wider impacts on the OA, neighbouring Boroughs and London as a whole.

7.144 As set out in the policy section of this chapter, London's population and employment are projected to grow very quickly over the next twenty years. As a result, London needs to increase its delivery of housing, and ensure that it has the right housing and commercial floorspace in the right places to accommodate that growth in a sustainable way.

7.145 The London Plan identifies OA's such as VNEB as the most suitable locations for high levels of investment and development to accommodate that growth. The VNEB OA has a minimum target of 16,000 new homes and 20,000 - 25,000 new jobs and the Plan recognises that the NLE is necessary to achieve those targets. The planning consents emerging in the area support this level of development with a projected 18,365 homes and 23,845 jobs set to be delivered with the NLE (see Table 7-10).

7.146 The NLE has a direct impact on the achievements of those targets because there is some development that has planning restrictions and so cannot come forward until the NLE is either underway or complete. There is also development that is not controlled in this way, but which is more likely to come forward, or come forward in greater quantities sooner, because the NLE is being delivered (in part because the NLE is likely to be important to attracting occupiers).

7.147 There is also a significant amount of development that has been consented and which is required to make a financial contribution to the delivery of the NLE, because the planning authorities have assessed that the NLE is required to make those schemes acceptable in planning terms. Whilst most of the planning consents are not directly linked to its delivery, the underlying assessments make clear that the failure to deliver the NLE would have a serious impact on the deliverability and sustainability of some of the consented schemes, and on the OA as a whole.

7.148 In addition to these impacts on development, the NLE will also have important labour market impacts and wider economic benefits. It will provide more jobs in the local area for existing residents to access and also provide local residents with improved access to jobs in other parts of London, thereby allowing them to move to more productive jobs. It will also deliver agglomeration benefits which will increase the productivity of existing workers across the Central Activities Zone.

7.149 In conclusion it is assessed that the NLE will have a **major beneficial** long term cumulative effect within the VNEB OA and Greater London.

References

Ref. 7-1 Department for Communities and Local Government (DCLG) (2012); National Planning Policy Framework

Ref. 7-2 Greater London Authority (GLA) (2011); The London Plan: Spatial Development Strategy for Greater London

Ref. 7-3 GLA (2008); The London Plan Spatial Development Strategy for Greater London (consolidated with Alterations since 2004)

Ref. 7-4 GLA (2012); Early Minor Alterations to the London Plan

Ref. 7-5 GLA (2012) Vauxhall Nine Elms Battersea Opportunity Area Planning Framework

Ref. 7-6 GLA (2010); Mayor's Transport Strategy

Ref. 7-7 London Borough of Lambeth (LBL) (2011); Lambeth Local Development Framework, Core Strategy

Ref. 7-8 London Borough of Wandsworth (LBW), (2010); Core Strategy Development Plan Document

Ref. 7-9 London Borough of Southwark (LBS) (2010); Core Strategy Development Plan Document

Ref. 7-10 LBS (2011); Southwark Plan: Saved Policies

Ref. 7-11 English Partnerships (2008); Additionality Guide: A Standard Approach to Assessing the Additional Impact of Projects, 3rd Edition, English Partnership, London

Ref. 7-12 Office for National Statistics (ONS) (2011); 2011 Census, ONS.

Ref. 7-13 ONS (2001); 2001 Census, ONS.

Ref. 7-14 SKM, Transport for London (TfL), GLA (2009); Vauxhall Nine Elms Battersea Opportunity Area Transport Study

Ref. 7-15 GLA Economics (2012); London's Economic Outlook, Autumn 2012

Ref. 7-16 ONS (2012); Annual Business Inquiry

Ref. 7-17 Department for Business, Enterprises and Regulatory Reform (BERR) (2011); Construction Statistics Annual 2011, HMSO, London

Ref. 7-18 Construction Skills Network, (2012); 'Blueprint for UK Construction Skills 2012-2016.' Available online at http://www.constructionskills.net/

Ref. 7-19 ONS (2012); Business Register and Employment Survey 2011

Ref. 7-20 ONS (2012); Claimant Count with Rates and Proportions

Ref. 7-21 DCLG (2007); Indices of Multiple Deprivation 2007

Ref. 7-22 TfL (2012); Northern Line Extension to Battersea: Updated Route Option Assessment

Ref. 7-23 LBL and Scott Wilson Ltd (2004); Lambeth Open Space Strategy

Ref. 7-24 LBL and Scott Wilson Ltd (2007); Lambeth Open Space Strategy Quality Audit Update

Ref. 7-25 Nine Elms Partnership (2012); Nine Elms Vauxhall Employment, Training and Business Charter

Ref. 7-26 GLA (2012); Delivering Responsible Procurement

Ref. 7-27 GLA (2012); Equal Life Chances for All – Revised February 2012

Ref. 7-28 GLA, TfL, LBL, LBW (2010); Vauxhall, Nine Elms, Battersea Development Infrastructure Funding Study

Ref. 7-29 ONS (2013); Nomis: Labour Market Profile: Ward Level, ONS

08 Archaeology and Built Heritage

Environmental Statement

Volume I

08 Archaeology and Built Heritage

Introduction

8.1 This chapter of the Environmental Statement (ES) assesses the likely significant effects of the proposed Northern Line Extension (NLE) on buried heritage assets (archaeological remains), and direct physical impacts upon individual above ground heritage assets (i.e. structures or features of historic interest such as listed buildings, Conservation Areas (CA) and Registered Parks and Gardens). Issues such as setting, the collective streetscape, CA character, views and visual effects, and the impact of noise, worksite massing or construction traffic are considered in *Chapter 15: Townscape and Visual Amenity*.

8.2 The chapter is supported by *ES Volume II: Appendix D*, which contains a historic environment assessment. The work has been undertaken by Museum of London Archaeology (MOLA) in accordance with the standards specified by the Institute for Archaeologists (Ref. 8-1) and other professional guidance (Ref. 8-2 to Ref. 8-4).

8.3 The chapter contains a description of the heritage planning policy context and the methods used to assess the potential effects of the NLE on known or likely heritage assets. It describes the baseline historic environment conditions currently existing at the site and in its immediate vicinity, provides a statement of significance of known above ground heritage assets and of possible buried heritage assets, the potential direct and indirect impacts of the NLE, and the mitigation measures required to prevent, reduce or offset any likely significant adverse impacts.

8.4 The proposed NLE will entail construction of two new stations (Battersea and Nine Elms) and two ventilation/access shafts (at Kennington Green and Kennington Park). Under Construction Option A, two temporary grout shafts would also be opened, at Harmsworth Street and Radcot Street. The ES assesses the effects of the NLE within the sites of the new stations and shafts for both options. For built heritage assets, the ES assesses the physical impacts from demolition and other works as well the potential impacts of any physical mitigation works implemented against the effects of settlement along the route.

8.5 Conservation Area Consent (CAC) is sought under the Transport and Works Act Order (TWAO) for the works at Kennington Park and Kennington Green. A Heritage Statement has been produced and is found in *ES Volume II: Appendix M*. A Listed Building Consent is also sought for works at Kennington station.

8.6 Only ground disturbance at or close to current ground level would have an impact on archaeological remains: the tunnels and their associated cross-passages would be bored well below the level of anthropogenic strata and would not have an archaeological impact. The whole-route impact on archaeological remains of mitigation (localised underpinning or additional piling) for settlement is also considered: these works would be likely to have a minor impact if any on built asset significance, but may have an impact on buried heritage assets. The extent and method for this mitigation will be determined by monitoring and ground investigations, and the archaeological environmental effect will be assessed once the results are known.

Planning Policy Context

National Legislation and Policy

National Planning Policy Framework (NPPF), 2012

8.7 The Government issued the NPPF in March 2012 (Ref. 8-5). 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"* (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 take 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). NPPF Section 12 'Conserving and enhancing the historic environment' is reproduced in full in *ES Volume II: Appendix D,* and summarised here.

8.8 The NPPF states that local planning authorities should "*set out in their Local Plan a positive strategy for the conservation and enjoyment of the historic environment*" (para 126) and conserve heritage assets "*in a manner appropriate to their significance*". Planning authorities should "*require an applicant to describe the significance of any heritage assets affected*", and where heritage assets with an archaeological interest might be affected, "*should require developers to submit an appropriate desk-based assessment and, where necessary, a field evaluation*" (para 128), taking this assessment into account when considering the impact of a proposal, "*to avoid or minimise conflict between the heritage asset's conservation and any aspect of the proposal*" (para 129). It states that "*a balanced judgement will be required having regard to the scale of any harm or loss and the significance of the heritage asset*" (para 135). Developers should be required to "*record and advance understanding of any heritage assets to be lost (wholly or in part)"* and make the evidence publicly accessible (para 141).

Regional Policy

The London Plan

8.9 The relevant Strategic Development Plan framework is provided by the London Plan, published in July 2011 (Ref. 8-6). It includes Policy 7.8 – Heritage Assets and Archaeology which states:

"*Strategic*

> *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;*
>
> *Development should incorporate measures that identify, record, interpret, protect and, where appropriate, present the site's archaeology.*

"Planning Decisions

Development should identify, value, conserve, restore, re-use and incorporate heritage assets, where appropriate;

Development affecting heritage assets and their settings should conserve their significance, by being sympathetic to their form, scale, materials and architectural detail;

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."

Local Planning Policy

8.10 The study area is a one kilometre (km) buffer around the proposed alignment, which falls within three local authorities, each of which has a Local Development Plan that sets out policies in relation to archaeology and built heritage.

London Borough of Wandsworth (LBW)

8.11 The LBW adopted its LDF Core Strategy in 2010 (Ref. 8-7) and the Development Management Policies Document (DMPD) in 2012 (Ref. 8-8).

8.12 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."

8.13 The DMPD sets out the Council's policies which include the protection and enhancement of the built heritage of the Borough. Policy DMS 2 'Managing the Historic Environment' states that:

"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."

8.14 It also specifies that:

"Proposals for development involving ground disturbance in Archaeological Priority Areas [APAs] (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."

London Borough of Lambeth (LBL)

8.15 Policy S9 'Quality of the Built Environment' of (LBL's LDF Core Strategy (Ref. 8-9) states that the LBL will seek to safeguard the borough's heritage assets, including 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."*

London Borough of Southwark (LBS)

8.16 The LBS LDF includes the LBS Core Strategy (Ref. 8-10) and saved policies from the Southwark UDP (Ref. 8-11).

8.17 The Core Strategy 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 [APZs] and sites, listed and locally listed buildings, registered parks and gardens, world heritage sites and scheduled monuments".

8.18 The saved Plan policies recognise the importance of Southwark's archaeological heritage as a community asset and also that it is under constant threat from future development. Policy 3.15 Conservation of the Historic Environment states that:

"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."

8.19 The LBS's policy in relation to archaeology (Policy 3.19 Archaeology) aims to ensure protection of important remains through the planning process, and adheres to the principles of national planning guidance (see above). The policy states that planning applications affecting sites within Archaeological Priority Zones 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."

8.20 *ES Volume II: Appendix D* includes additional extracts from the local plans regarding the general approach to heritage assets within each of the boroughs.

Assessment Methodology and Significance Criteria

Assessment Methodology

Scope

8.21 The principal impacts on archaeological remains would arise in the two station sites and two permanent shaft sites (and the associated distillery water tank construction), with the addition of two temporary shafts under the alternative construction option. All these sites have been assessed individually. Whole-route impacts on built and buried assets arising from settlement mitigation are also considered.

8.22 The NLE running tunnels will be far below the level of anthropogenic strata and would not have an archaeological impact. This chapter therefore considers the impact of the shafts and the station box footprints, where all archaeological remains would be removed. Additional impacts within the temporary worksites have also been taken into account, for example; groundworks/excavation for any crane bases, generators and compressors, ventilation plants, storage areas, offices and car parking. Any underpinning of buildings predicted to be at risk from settlement would also have a potential archaeological impact.

8.23 This chapter considers adverse impacts upon built heritage assets of very high to low sensitivity (i.e. Grade I, II*, II listed or locally listed buildings, and non-designated built assets of heritage interest). 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.

Assumptions and Limitations

8.24 The effects on buried heritage assets of ground remediation against settlement resulting from tunnel construction have been assessed to the extent that information is currently available. These effects may result from grout shafts and underpinning or additional piling to buildings. However, the effect of compensation grouting by means of injection into the ground from either grout shafts or from beneath (within the tunnel) have not been assessed in terms of the depths or spatial extent, as it is considered that there is no available mitigation.

8.25 The elements of ground remediation for which mitigation is feasible will be assessed further in the light of detailed design information and the results of geotechnical investigation.

8.26 Where assets which would be affected by the NLE might also be affected by other schemes, e.g. the Banham Security Ltd building at the Nine Elms station site which would also be demolished under the Sainsbury's scheme, it has been considered prudent to include these in the NLE assessment.

8.27 Where asset sensitivity and magnitude of change has been assessed as uncertain based on this desk study information, it is assumed that further archaeological and built heritage investigation will be detailed and agreed under consultation with suitable stakeholders including English Heritage (EH), Local Planning Authorities and landowners, conducted under the Planning Direction Conditions.

Baseline Characterisation

8.28 As stated above, the study area is a 1km buffer around the proposed alignment. The methodology and sources consulted for the baseline characterisation are set out in detail in *ES Volume II: Appendix D*. In summary, this entailed:

- Establishing both known baseline conditions and the potential for further discovery of buried heritage assets (archaeological remains: assets which are currently not visible and are intangible) within a 250 metre (m) radius 'study corridor' around the site. Archaeological literature and standard published and documentary sources were consulted, along with the National Monuments Record (information on statutory designations including scheduled monuments and listed buildings, and data held by the primary repositories of archaeological information within Greater London; i.e. the Greater London Historic Environment Record (GLHER) as managed by EH, and the London Archaeological Archive Research Centre (LAARC);
- Local planning authority websites for information on conservation areas and locally listed buildings; and
- Site visits (carried out on 29th July 2010, 13th and 19th April 2012, 14th January and 28th February 2013) in order to determine the topography of the site, existing land use, the nature of the existing buildings within the immediate vicinity of each work site and to provide further information on areas of possible past ground disturbance and general archaeological potential.

Method of Assessment

8.29 The assessment has been carried out in accordance with the standards specified by the Institute for Archaeologists, EH and the Association of Local Government Archaeological Officers (Ref. 8-1 to Ref. 8-4). The methodology used to determine the significance of heritage assets, the severity of any impacts upon them and the significance of resultant effect is in general accordance with that set out in *Chapter 2: EIA Methodology*, and as summarised below. Following the collection of baseline data, the method used to assess potential environmental effects included:

- An evaluation of the significance of heritage assets (based on existing designations; and professional judgment where such resources have no formal designation; and considering evidential, historical, aesthetic and communal value (as outlined in the EH Conservation Principles);
- Predicting the magnitude of the likely development impacts upon the known or potential significance of heritage assets;
- Considering the mitigation measures (including against settlement impacts) that have been included within the NLE design (and any additional action that might be required in the design and construction or operational lifetime of the NLE) in order to reduce or eliminate any significant adverse effects upon heritage assets; and
- Quantifying any residual effects (those that might remain after mitigation) along with the overall cumulative effect.

Significance Criteria

Sensitivity of Buried Heritage Assets

8.30 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 (Ref. 8-12). 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. Known and potential buried heritage assets within the site and its vicinity have been identified from national and local designations, GLHER data and expert opinion. The determination of the sensitivity of these assets is based on statutory designation and/or professional judgement against four values:

- **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 assets to the present, such a connection often being illustrative or associative; and
- **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.

8.31 Unless the nature and extent of buried, concealed archaeological remains within any given area has been determined through prior investigation, the significance of these potential heritage assets which comprise below ground archaeological remains is often uncertain. Table 8-1 gives examples of the sensitivity of designated and non-designated heritage assets.

Sensitivity of Built Heritage Assets

8.32 Built heritage (and above ground archaeological remains such as earthworks or 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 or around 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 EH 'Conservation Principles' (Ref. 8-13) and applicable guidance on selecting buildings for listing (or designation as heritage assets) (Ref. 8-14) and on investigating and recording buildings archaeologically (Ref. 8-15). Criteria for listing includes:

- *"**Architectural interest**:...of importance in its architectural design, decoration or craftsmanship; special interest may also apply to nationally 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, and/or have close historical association with nationally important people";*
- ***Group value**, particularly "where buildings comprise an important architectural or historic unity or a fine example of planning…".*

8.33 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.

8.34 Sites and their surroundings often include buildings, features or structures which are of heritage sensitivity despite not being designated, either nationally or locally. 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 NLE.

Table 8-1 Sensitivity of Heritage Assets

Asset Sensitivity	Examples
Very High (International/ national)	World Heritage Sites. Scheduled Ancient Monuments. Grade I and II* listed buildings. Grade I and II* Registered parks and gardens. Non-designated sites, settlements and landscapes of equivalent status (exceptional heritage value).
High (National/regional)	Grade II listed buildings. Conservation areas. Grade II Registered parks and gardens. Designated historic battlefields. Burial grounds. Protected heritage landscapes (e.g. ancient woodland or historic hedgerows) Non-designated sites, settlements and landscapes of equivalent status (rare and well-preserved examples).
Medium (Metropolitan)	Non-designated sites, Locally Listed Buildings, settlements and landscapes of equivalent status (good preservation, sufficient for comparative study and educational/cultural appreciation).
Low (District/Parish)	Low significance and/or poor state of preservation resulting in resources of no more than local value.
Very Low	Insignificant and/or badly damaged resources of little appreciable value.
Uncertain	Resources that have clear potential, but for which current knowledge is insufficient to allow significance to be determined.

Magnitude of Change

8.35 Determination of magnitude of impact upon the sensitivity of the known or potential heritage asset is based on the severity of the proposed impact (e.g. from piling, ground reduction, etc). Table 8−1 describes the significance of designated and non-designated heritage assets while Table 8-2 provides guidance criteria used to determine the magnitude of change. The magnitude of change and its significance to archaeological deposits is thus determined by comparing the significance of the baseline heritage asset with the magnitude of impact upon that asset resulting from the NLE.

Table 8-2 Magnitude of Change Criteria

Magnitude of Change	Description of Change
High	Physical loss of evidence and/or features fundamental to the understanding and character of the resource; and/or The loss or severance of the physical and visual integrity of parts of a resource, such that key relationships between the parts are lost.
Moderate	The physical loss of evidence and/or features which contribute substantially to the understanding and character of the resource, but are not fundamental to it (i.e. where sufficient evidence or features survive the impact for the resources essential character to be understood and interpreted); and/or The loss or severance of the physical and visual integrity of parts of a resource, such that important relationships between the parts are lost, but not those fundamental to the character of the resource and its interpretation (these are most likely to be where the impact is peripheral, or affects features where their integrity or relationships have already been diminished to a significant extent). Change to the asset resulting in an appreciable change in the ability to understand and appreciate the resource and its historical context and setting.
Low	The physical loss of evidence and/or features likely to be replicated to a significant degree in the remaining, unaffected, parts of the resource, or which are of minor importance; and/or Where the physical and visual integrity of resource is already limited and additional loss or severance does not lead to the loss of important surviving relationships.
Uncertain	Level of survival/condition of asset in specific locations is not known: Magnitude of Change is therefore not known.

Significance of Environmental Effect

8.36 The significance of an environmental effect is determined by comparing the significance of the baseline heritage asset with the magnitude of impact upon that asset resulting from the NLE, as outlined in Table 8-1 and Table 8-2. The likely significant effects may be either adverse (negative) or beneficial (positive) and are defined initially without mitigation. An appropriate mitigation strategy would aim to eliminate any potential adverse impact or reduce it to an acceptable level. Where information is insufficient to quantify the asset sensitivity or magnitude of change, the significance of the effect is given as uncertain.

8.37 The criteria for assessing the significance of the environmental effects are outlined in Table 8-3. This defines significant and non-significant effects on the basis of levels of impact (high, moderate, low, uncertain) and the sensitivity of the heritage asset (high to uncertain). As development results in the removal of finite and non-renewal buried heritage assets, the effects are usually adverse. An appropriate mitigation strategy would aim to eliminate or reduce to an acceptable level, any adverse effect.

Table 8-3 Significance of the Environmental Effect

Magnitude of Change	Sensitivity of Asset					
	Very high	**High**	**Medium**	**Low**	**Very Low**	**Uncertain**
High	major	major	major	moderate	minor	uncertain
Moderate	major	major	moderate	minor	minor	uncertain
Low	moderate	moderate	minor	minor	negligible	uncertain
Negligible	minor	minor/ negligible	negligible	negligible	negligible	uncertain
Uncertain	uncertain	uncertain	uncertain	uncertain	uncertain	uncertain

Mitigation and Residual Effects

8.38 Measures to mitigate impacts may comprise design adjustments, to allow important resources to be protected and retained (i.e. conserved *in situ* – reducing the magnitude of change) or, where this is not feasible, investigation and recording before and during development (i.e. preservation by record). The residual effect reflects the success rating for the recommended mitigation strategy. It may be beneficial, negligible or adverse. Under certain circumstances (e.g. fully investigated, analysed and published archaeological investigation) the preservation by record of an asset may result in the recovery of important information and so result in a minor beneficial effect. However, where development results in the removal of finite and non-renewable buried heritage assets, the effects would be adverse. An appropriate mitigation strategy would aim to eliminate or reduce to an acceptable level, any adverse effect. The assessment of residual effects has been conducted with reference to the significance criteria detailed in Table 8-4.

Table 8-4 Residual Effect (effect after mitigation)

Residual Effect	Criteria
Major Adverse	Negative residual effect that would be an important consideration at a national level.
Moderate Adverse	Negative residual effect that would be an important consideration at a regional or county level.
Minor Adverse	Negative residual effect that would be a relevant consideration in a local context.
Negligible	Residual effect that is nil, imperceptible, negligible, not significant.
Uncertain	It is not possible to quantify the significance of residual effect due to lack of information.
Minor Beneficial	Positive residual effect that would be a relevant consideration in a local context.
Moderate Beneficial	Positive residual effect that would be an important consideration at a regional or county level.
Major Beneficial	Positive residual effect that would be an important consideration at a national level.

Baseline Conditions

Designated Heritage Assets

8.39 Listed buildings, CAs, archaeological find spots and Archaeological Priority Areas or Zones (APA/Zs) are shown in Figure 8-1.

8.40 Kennington Park in the LBL is registered for its special historic interest (Grade II) under the Historic Buildings and Ancient Monuments Act 1953 in the Register of Historic Parks and Gardens maintained by EH. The north-eastern section of the proposed route (southbound) crosses Kennington Park and the southbound ventilation shaft and head house site is located in the northern edge of the park.

8.41 Kennington station, where new passenger cross passages are proposed, is Grade II listed. The Battersea station site contains cranes on the Thames-side jetty included in the listing of Battersea Power Station (BPS). 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) and lie within or close to a CA.

8.42 The northern sections of the proposed NLE route (northbound and southbound) cross two APZs in Lambeth. The southern section of the proposed NLE route (northbound and southbound) crosses an APA in Wandsworth.

Topography and Geology

8.43 The proposed route extends from Kennington Loop to BPS, with proposed additional cross passages within Kennington station. The geology of the study corridor comprises Thames Gravels (also known as terrace gravels), overlaid by deep alluvium in the western part of the proposed NLE route, which marks the location of a palate-channel, a broad buried channel, known as the Battersea Channel (see Figure 8−2). 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 ‘eyes’, and are thought to relate to remnants of former channels of the River Thames, as it flowed across the area around 30,000 to 150,000 years ago. The higher gravel to the west has been referred to as the Battersea eyot (Ref. 8-16).

8.44 One borehole at the western part of the proposed route, recorded gravel at –3.6m Ordnance Datum (OD), overlain by a mixed deposit interpreted as the fill of a deeply-cut feature, possibly the Battersea palaeochannel. Geotechnical information available from the area and surrounding sites indicates that the anticipated levels of the natural geology along the proposed NLE route would be as follows: the top of the alluvium would be between 4.6m OD and −0.75m OD. The terrace gravels would be encountered between 4.1m OD and –1.95m OD.

Archaeological and Historical Background

8.45 This section provides a route-wide overview by period, with site-specific features highlighted under *Archaeological and Built Heritage Potential* below. Further detail is provided in *ES Volume II: Appendix D*.

Past Investigations

8.46 There have been numerous past archaeological investigations in the close vicinity of the proposed NLE route; however, other than the archaeological monitoring of the geotechnical boreholes mentioned above, none have found significant archaeological remains. Either negative evidence or post-medieval and modern building foundations were noted at all sites investigated. A single shard of redeposit Roman pot was found during a watching brief at 33 Stannary Street, Lambeth, in 2004.

Prehistoric Period (c. 700,000 BC – AD43)

8.47 Much of the western end of the proposed NLE route would have remained a marshy wetland landscape periodically inundated during flood events and strong tidal surges. Marine transgressions at the end of the early prehistoric period resulted in inundation of the low-lying areas, creating an inertial 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 grazing, fishing, fowling, salt making, exploitation of sources of craft materials (willows, reeds and rushes) and pottery manufacture.

8.48 In the south-western and eastern parts of the proposed NLE route, the land gradually rises up onto higher areas of sand and gravel. These would have been more 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.

8.49 The waterlogged conditions and the ‘protective’ layer of alluvium in the vicinity of the former Battersea Creek mean that any wood or organic remains may be well preserved. Timber track ways may have been constructed in the prehistoric period which would have provided access across the marshes, along with a network of creeks and fleets, which would have provided the most direct access to the River Thames from the higher ground on which the settlements would have been located.

8.50 There are few finds noted by the GLHER in the vicinity of the proposed NLE route. A Mesolithic (c 10,000–4,000 BC) flint pick was recovered from the Thames foreshore at the western end of the study area. A possibly Mesolithic or Neolithic stone axe and a Bronze Age spearhead were found by chance in the 19th century in the vicinity of the Battersea station site during the construction of the Southwark and Vauxhall Water Works.

Roman Period (AD43 – 410)

8.51 The Roman town of Leninism was located c 3.8km to the north-east of the proposed NLE route. The Roman road known as Stone Street connecting London to the Channel ports and south coast follows closely the modern A3 Clapham Road, and is crossed by the eastern end of the proposed NLE route at its junction with Camberwell New Road. Farming and quarrying were concentrated along roads outside settlements. Roman law required the dead to be buried outside settled areas and cemeteries were also located along roads, close to the communities they served. During this period, the eastern part of the proposed NLE 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.

8.52 Few remains dated to this period have been recovered within the study area. A Roman lead coffin and four skeletons were found in 1794 at Battersea Fields, just outside the western end of the study area. Also reported from Battersea Fields is a Roman bronze coin of Antonio's Pius minted in c AD 144 and found in c 1857. A possible section of Roman Stone Street was recorded at 37 Clapham Road, Lambeth, during roadworks along Clapham Road.

Early Medieval period (AD 410–1066)

8.53 The Saxon trading settlement of Lundenwic was established c 3.5km north-east of the proposed NLE route, between the old Roman city and what would become Westminster. During this period, the eastern part of the proposed NLE route would have been on higher/dry ground on the gravel terrace, whilst the remaining parts of the route remained prone to flooding. Efforts may have been made to drain marshland in the area 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 within open land, either cultivated or used as pasture. Although much of the proposed NLE route was in areas unsuitable for habitation, it would have provided access to valuable resources. No settlements of Saxon date have been identified within the study area and the nearest possible areas of settlement centre on Vauxhall c 800m north of the proposed NLE route.

Later Medieval period (AD 1066–1485)

8.54 During this period, it is likely that the low-lying areas in the western part of the NLE route began to be more comprehensively drained and reclaimed. This would have taken place in stages, with a number of successive sea walls and drainage ditches being constructed as more and more of the marshland was reclaimed. The purpose would have been primarily economic, creating good quality grazing for livestock and fertile land for crops. As with earlier periods, the higher ground to the east would have been the first choice for settlement, providing dry and fertile land with good access to the river and its tributary.

Post-medieval period (AD 1485–present)

8.55 Rocque's map of London dating to 1741–45 shows the western end of the proposed NLE route 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 River 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 NLE route), and on the western side of Kennington Common, much of which is now Kennington Park.

8.56 The Ordnance Survey 1inch:1mile map of 1822 shows that the eastern part of the study area has been rapidly developed with residential housing, and has lost its former rural character. The later medieval roads remain as the main highways in the area, and are largely lined with houses. A small settlement is shown on the eastern side of the former Battersea Common Field, called Battersea New Town. The remainder of this area is still open ground, called Battersea Fields.

8.57 Stanford's map of London, dating to 1862 shows that the entire length of Wandsworth Road has been developed, with terraced houses and villas, and large gardens to the rear. To the west of this is a strip of land labelled as meadow land. To the west of the meadow land, the former Battersea Common has been partly developed with market gardens, reservoirs and terraced housing, indicating the future industrial use of this area. The eastern end of the proposed NLE route crosses an area of more densely built terraced housing, interspersed with industrial buildings, such as a vinegar factory noted in the GLHER. The Surrey Cricket Ground at the Oval is shown on this map.

8.58 The London Bomb Damage map shows that, like much of central and industrial London, the area was heavily bombed during World War Two. The bomb map records the locations of numerous V1 flying bombs which dropped in the area causing serious to minor damage along the area of the proposed NLE route (Ref. 8-17).

8.59 During the second half of the 20th century, the eastern part of the area of the proposed NLE route was redeveloped largely for residential buildings, whilst the western part of the area was developed with industrial buildings.

Archaeological and Built Heritage Potential

8.60 Buried heritage potential at each of the sites assessed has been described, from east to west:

Harmsworth Street, temporary grouting shaft worksite

8.61 The site is not located within an APZ. It was open ground until the late-18th century when it incorporated the newly developed street layout between terraced housing. No impacts other than street surface and service works have been identified within the site, and therefore survival potential is anticipated to be high for any archaeological remains of early periods.

8.62 Archaeological potential is predicted as follows:

- Low potential for agricultural remains of the medieval to post-medieval periods. The sensitivity of such remains would be low to very low; and

- Uncertain, possibly low, potential for previously unrecorded prehistoric and Roman remains. The sensitivity of such remains is uncertain (low to high) and would depend on date, nature, extent and preservation.

8.63 Built heritage potential is predicted as follows:

- The site is within the setting of The Bishops House, the gate piers to The Bishop's House, 10 Kennington Park Place and 11 – 12 Kennington Park Place, all Grade II listed and therefore of high sensitivity; and
- The site is within the setting of a number of undesignated buildings of low sensitivity.

Radcot Street, temporary grouting shaft worksite

8.64 The site is not located within an APZ. It was within open ground until the mid-19th century when it was incorporated into the newly developed street layout between terraced housing. No impacts other than street surface and service works have been identified within the site. Archaeological survival potential is therefore anticipated to be high for any early remains.

8.65 Archaeological potential is predicted as follows:

- Low potential for agricultural remains of the medieval to post-medieval periods. The sensitivity of such remains would be low /very low; and
- Uncertain, possibly low, potential for previously unrecorded prehistoric and Roman remains. The sensitivity of such remains is uncertain (low to high) and would depend on date, nature, extent and preservation.

8.66 Built heritage potential is predicted as follows:

- The site is within Kennington Conservation Area, and of high sensitivity;
- The site is within the setting of 164 – 170 and 170A Kennington Park Road, 140 – 162 Kennington Park Road, 125 – 165 Kennington Park Road, 136A Kennington Park Road, The White Bear Pub, 114 – 124 Kennington Park Road, 21 – 25 Cleaver Square, 26 – 33 Cleaver Square and 126 – 132 Kennington Park Road, all Grade II listed and of high sensitivity; and
- The site is within the setting of a number of undesignated buildings of low sensitivity.

Kennington Park worksite

8.67 The site is not within an APZ. It is within Kennington Park, a Grade II Registered Historic Park and Garden. The site was open ground and in the mid-19th century it was incorporated into Kennington Park. No impacts other than garden works have been identified within the site. Archaeological survival potential is therefore anticipated to be high for any early remains.

8.68 Archaeological potential is predicted as follows:

- Uncertain, probably low, potential for agricultural remains of the medieval to post-medieval periods. The sensitivity of such remains would be low to very low; and
- Uncertain, possibly low, potential for previously unrecorded prehistoric and Roman remains. The sensitivity of such remains is uncertain (low to high) and would depend on date, nature, extent and preservation.

8.69 Built heritage potential is predicted as follows:

- The site contains one unlisted building, a lodge built in 1938 (referred to in this ES as Kennington Park Lodge), that is of low sensitivity;
- The site lies within the LB Lambeth's St Marks CA and immediately adjacent to LB Southwark's Kennington Park Road CA, both of high sensitivity;
- The site is within the medium distance setting of Prince Consort Lodge (erected here on the western edge of the park in 1852), which is Grade II* listed and an asset of very high sensitivity;
- The site is within the setting of The Bishops House, the gate piers to The Bishops House, 10 Kennington Place, 11 – 12 Kennington Place and 1 – 7 Agnes Place and railings all Grade II listed buildings of high sensitivity;
- The site is within the setting of a number of undesignated buildings of low sensitivity; and
- The site lies within Kennington Park which is protected by a Grade II listing on the Register of Historic Parks & Gardens.

Kennington Green worksite

8.70 The site is not within an APZ. The shaft site was open ground including a pond until the late-18th century when it was incorporated into the new street layout and associated housing developments. A pair of semi-detached houses stood on the north side of Montford Place until the mid-20th Century, now the site of a *c.*2002 three-sided roofless structure forming a 'screen' beside the distillery entrance. Otherwise no impacts other than garden works have been identified within the site. Archaeological survival potential is therefore anticipated to be high for any early remains. The site of the distillery water tank was built up with terraced houses by the mid-19th century, replaced by an industrial or commercial building in the early-20th century.

8.71 Archaeological potential is predicted as follows:

- High potential for remains of the 20th-century works, considered of low sensitivity;
- Moderate to low potential for remains of the late 18th century and mid-19th century houses, considered of low sensitivity;
- Moderate potential for agricultural remains of the medieval to post-medieval periods. The sensitivity of such remains would be low /very low; and
- Uncertain, possibly low, potential for previously unrecorded prehistoric and Roman remains. The sensitivity of such remains is uncertain (low to high) and would depend on date, nature, extent and preservation.

8.72 Built heritage potential is predicted as follows:

- The site lies within the Kennington CA and under/adjacent Kennington Green which is protected by the London Squares Act 1931;
- The site is within the setting of Nos 3 and 7-25 Montford Place, 362, 364 and 366 Kennington Place, 356 Kennington Place, 354 Kennington Place, 350 and 352 Kennington Place, 348 Kennington Place, 346 Kennington Place, The former Vauxhall Manor School now The Lycee, Stannary Street, Old Town Hall, 367 Kennington Road, 328 Kennington Road, 324A and 326 Kennington

Road, 320 and 322 Kennington Road, 318 Kennington Road, all listed at Grade II and of high sensitivity. (NB - Nos 350 & 352 are Grade II* listed);

- The site is within the setting of a locally listed building of moderate sensitivity, 377 Kennington Road, and other undesignated buildings of low sensitivity;
- The 'screen' forming the distillery boundary wall is of very low sensitivity.

Nine Elms Station

8.73 The site's limits of deviation extend west into an APA. Parts of the site have been built up since the mid-19th century. The majority of these buildings probably had simple strip footings or half basements up to a maximum of 1.5m deep, the construction of which will have truncated earlier remains. The bases of deep cut features, such as pits, ditches and wells may survive beneath this truncation, in particular where there are deeper alluvial deposits.

8.74 Archaeological potential is predicted as follows:

- Moderate potential for remains of mid to late 19th century houses brewery buildings and railway marshalling yard and stores buildings, considered of low sensitivity, derived from the possible limited evidential and historical value;
- Moderate to low potential for agricultural remains of the Roman, medieval to post-medieval periods. The sensitivity of such remains would be medium to low/ very low depending on nature and extent;
- Uncertain potential for prehistoric remains within and beneath the alluvium. The sensitivity of any such remains, if present, is uncertain (potentially high) and would depend on nature, extent and preservation; and
- Moderate potential for geo-archaeological and palaeo-environmental remains, considered of medium sensitivity for the understanding of past landscapes.

8.75 Built heritage potential is predicted as follows:

- The site contains 19th and 20th century undesignated industrial buildings of low to moderate sensitivity.

Battersea Station

8.76 The station site is not within an APA, but the conveyor route and jetty are within an APA designated for the archaeological and palaeoenvironmental potential of the Thames riverside and floodplain. Construction of the Southwark and Vauxhall Water Works reservoir in the area of the site in the 19th century would have heavily truncated or removed entirely any earlier archaeological remains. The reservoirs were probably excavated down to the underlying natural gravel, completely removing any archaeological remains within the alluvium. Early prehistoric features cut into the underlying gravels might potentially survive intact. The remains of the reservoir would potentially be of archaeological interest. Later the site of a Great Western Railway goods depot and sidings, and the BPS jetty.

8.77 Archaeological potential is predicted as follows:

- High potential for remains of the reservoir (e.g. structural walls). Such remains would be of low sensitivity, based on the limited evidential and historical value;
- High potential for remains of the early 20th-century goods depot and associated railways and buildings, considered of very low/negligible sensitivity, based on the limited evidential and historical value;
- High potential for palaeoenvironmental remains, of medium significance for the understanding of past landscapes;
- 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; and
- Low potential for early prehistoric remains cut into the terrace gravels, of uncertain sensitivity, derived from the potential evidential value. This would depend on the nature, extent and preservation of any remains.

8.78 Built heritage potential is predicted as follows:

- The site contains two cranes, a jetty and intake and outlet chambers which are within the curtilage of the Grade II* listed BPS, and part of the river wall, likely to date to the mid-19th century or earlier;
- The site is within the setting of BPS, a Grade II* listed building of very high sensitivity, and Battersea Water Pumping Station, a Grade II listed building of high sensitivity; and
- The site is within the setting of a locally listed building (Whittington Lodge) of medium sensitivity and undesignated buildings of low sensitivity.

Kennington station

8.79 Kennington station is a Grade II listed building constructed 1890–1925 for the City and South London Railway, and of high sensitivity. The impact of the proposed platform-level cross-passages would be limited to the fabric of the station itself. No other heritage assets would be affected.

Potential Effects

Construction phase

8.80 Potential effects on archaeological remains (buried heritage assets) would arise from groundworks and excavations which extend beyond/beneath any modern made ground and remove or truncate archaeological deposits or features: these impacts would be at the work compounds, station and shaft sites. Along the route, compensation grouting and ground stabilisation, and mitigation for ground settlement affecting buildings or services (e.g. underpinning or grouting), would also have a potential impact.

8.81 Potential effects on built heritage considered in this chapter principally comprise physical changes (e.g. demolition or part-demolition) and changes to the immediate setting. No listed buildings have been identified which would be physically impacted upon, other than any underpinning or other compensation for settlement, which has been classed as mitigation, and is assumed if carried out in accordance with a Listed Building Consent to have no adverse effect. Non-designated built assets of heritage significance which could be affected are discussed in the relevant site summaries below.

8.82 Predicted noise levels of the proposed development would need to be confirmed and updated following further surveys during detailed design, 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.

8.83 The impact of setting is assessed in *Chapter 15: Townscape and Visual Amenity* and within the Heritage Statement in the Design and Access Statement *(ES Volume II: Appendix M)*

8.84 This desk based assessment provides sufficient information in understanding the potential for significant environmental effects and mitigation measures, before further surveys are completed during later stages.

Mitigation for building settlement (whole-route impact)

8.85 Mitigation to buildings for any ground settlement (e.g. underpinning) may itself have impacts on buried archaeological remains. These remains have been assessed as baseline assets, in the areas where underpinning may be required. The resulting environmental effect and appropriate mitigation will be assessed during detailed design.

8.86 In addition to the settlement impacts outlined below, 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.

Archaeological effect of mitigation for ground settlement (whole-route impact)

8.87 Mitigation for ground settlement may have an archaeological impact, in terms of any grouting shafts opened from ground level and the solidification of any archaeological layers in the area of impact. The location, extent and method of mitigation for ground settlement are described in *ES Volume II: Appendix I2*, and consequently the archaeological environmental effect and appropriate mitigation will be assessed once this is known.

Archaeological effect of mitigation for utility damage from settlement (whole-route impact)

8.88 Utilities vulnerable to critical settlement damage have been identified along the proposed 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.

Harmsworth Street, temporary grouting shaft worksite

8.89 Works at this shaft would entail excavation of the 5.0m internal diameter (ID) shaft down to c −23.0m OD (c 27.0m below ground level). The following effects have been identified within the site:

- Preparatory groundworks which extend beyond/beneath any modern made ground would truncate or remove entirely any archaeological remains in the area of impact; and
- Excavation of the shaft will remove any archaeological remains within its footprint.

8.90 Table 8-5 sets out the likely effect upon heritage assets prior to the implementation of a mitigation strategy.

Table 8-5 Harmsworth Street - Archaeological and Built Heritage Effects Prior to Mitigation

Heritage Asset	Sensitivity	Magnitude of Change	Significance of Effect (prior to mitigation)
Moderate potential for agricultural remains of the medieval to post-medieval periods.	Very Low to Low	High - preparatory groundworks and shaft excavation	Minor to Moderate Adverse
Uncertain, possibly low, potential for previously unrecorded prehistoric and Roman remains.	Uncertain (low to high)	High - preparatory groundworks and shaft excavation	Uncertain (possible Moderate to Major Adverse)
125 – 165 Kennington Park Road	High	Negligible following settlement mitigation	None
1 – 6 and 68 – 72 De Laune Street	Low	Negligible following settlement mitigation	None

Radcot Street, temporary grouting shaft worksite

8.91 Works at this shaft would entail excavation of the 5.0m ID shaft down to c −21.3m OD (c 26.0m below ground level). The following effects have been identified within the site:

- Preparatory groundworks which extend beyond/beneath any modern made ground would truncate or remove entirely any archaeological remains in the area of impact; and
- Excavation of the shaft will remove any archaeological remains within its footprint.

8.92 Table 8-6 sets out the likely effect upon heritage assets prior to the implementation of a mitigation strategy.

Table 8-6 Radcot Street - Archaeological and Built Heritage Effects Prior to Mitigation

Heritage Asset	Sensitivity	Magnitude of Change	Significance of Effect (prior to mitigation)
Moderate potential for agricultural remains of the medieval to post-medieval periods.	Very Low to Low	High - preparatory groundworks and shaft excavation	Minor to Moderate Adverse
Uncertain, possibly low, potential for previously unrecorded prehistoric and Roman remains.	Uncertain (low to high)	High - preparatory groundworks and shaft excavation	Uncertain (possible Moderate to Major Adverse)
5 – 9 and 6 – 14 Ravensdon Street; 1 – 6 Radcot Street	Low	Negligible following settlement mitigation	None

Kennington Park worksite

8.93 Works at this shaft would entail excavation of the 13.5m ID shaft down to c −23m OD (c 27.0m below ground level) and construction of a 9.0m x 9.0m head house to c 8.6m high in the north-east corner of the Park. The following effects have been identified within the site:

- Preparatory groundworks which extend beyond/beneath any modern made ground would truncate or remove entirely any archaeological remains in the area of impact;
- Construction of retaining wall will remove any archaeological remains within its footprint;
- Excavation for the shaft, sub-station and head house basement will remove any potential archaeological remains within their footprint; and
- Demolition of Kennington Park Lodge built in 1938 (unlisted but in the St Mark's CA and within Kennington Park, though not forming part of the public area), removal of adjacent railings and a head house constructed and a new community facility provided.

8.94 Table 8-7 sets out the likely effect upon heritage assets prior to the implementation of a mitigation strategy.

Table 8-7 Kennington Park - Archaeological and Built Heritage Effects Prior to Mitigation

Heritage Asset	Sensitivity	Magnitude of Change	Significance of Effect (prior to mitigation)
Moderate potential for agricultural remains of the medieval to post-medieval periods	Very Low to Low	High - preparatory groundworks and shaft and basement excavation	Minor to Moderate Adverse
Uncertain, possibly low, potential for previously unrecorded prehistoric and Roman remains	Uncertain (low to high)	High - preparatory groundworks and shaft and basement excavation	Uncertain (possible Moderate to Major Adverse)
Kennington Park	High	Negligible – demolition of lodge	Minor Adverse / None
20th century cottage/lodge	Low	High – demolition	Major Adverse

Kennington Green worksite

8.95 Works at this shaft would entail excavation of the 13.5m ID shaft down to c −23m OD (c 25.0m below ground level), excavation for sub-surface tunnel ventilation duct crossing Kennington Green and Montford Place, and head house basement, down to c –2.45m OD (c 6.0m below ground level). A head house will be constructed at the entrance to the distillery in Montford Place which is within the Kennington CA. The existing 'screen' forming the boundary wall is to be demolished. The head house to be built in this location will have a roofline higher than the existing screen. A water tank will be constructed to the north of the distillery on Montford Place, and a section of palisade fence will be removed. The following effects have been identified within the site:

- Preparatory groundworks which extend beyond/beneath any modern made ground would truncate or remove entirely any archaeological remains in the area of impact;
- Construction of retaining wall, piling for head house construction and water tank foundations will remove any archaeological remains within the footprint of the works; and
- Excavation for the shaft, ventilation tunnel and head house basement will remove any potential archaeological remains within their footprint.

8.96 Table 8-8 sets out the likely effect upon heritage assets prior to the implementation of a mitigation strategy.

Table 8-8 Kennington Green - Archaeological and Built Heritage Effects Prior to Mitigation

Heritage Asset	Sensitivity	Magnitude of Change	Significance of Effect (prior to mitigation)
Possible remains of the 20th century works	Low	High - preparatory groundworks and shaft and basement excavation	Moderate Adverse
Possible remains of the mid-19th century houses	Low	High - preparatory groundworks and shaft and basement excavation, foundations for water tank	Moderate Adverse
Moderate potential for agricultural remains of the medieval to post-medieval periods.	Very Low to low	High - preparatory groundworks and shaft and basement excavation, foundations for water tank	Minor to Moderate Adverse
Uncertain, possibly low, potential for previously unrecorded prehistoric and Roman remains.	Uncertain (low to high)	High - preparatory groundworks and shaft and basement excavation, foundations for water tank	Uncertain (possible Moderate to Major Adverse)
362 – 366 Kennington Road	High	Negligible following settlement mitigation	None
*c.*2002 screen structure forming part of the boundary wall	Very Low	High – demolition	Minor Adverse/ none

Nine Elms Station

8.97 Works at this station would entail site preparation comprising demolition of existing buildings within the site, construction of diaphragm walls (retaining walls) at the station sides requiring a 1.2m wide trench around the station box footprint; and excavation of a station box of 115m x 38m built in a cut-and-cover trench down to c –23.5m OD. The following effects have been identified within the site:

- Preparatory groundworks which extend beyond/beneath any modern made ground would truncate or remove entirely any archaeological remains in the area of impact;
- Construction of retaining wall will remove any archaeological remains within its footprint;
- Excavation of the cut-and-cover station box will remove any archaeological remains within its footprint; and
- Unlisted buildings of the late 19th century of heritage significance (currently occupied by Banham Security Ltd) would be demolished, and others including the incinerator and chimney.

8.98 Table 8-9 sets out the likely effect upon heritage assets prior to the implementation of a mitigation strategy.

Table 8-9 Nine Elms - Archaeological and Built Heritage Effects Prior to Mitigation

Heritage Asset	Sensitivity	Magnitude of Change	Significance of Effect (prior to mitigation)
Possible remains of mid to late 19th century houses brewery buildings and railway marshalling yard and stores buildings	Low	High - preparatory groundworks and excavation for retaining walls and station box	Minor Adverse
Possible remains of the mid-19th century houses	Low	High - preparatory groundworks and excavation for retaining walls and station box	Minor Adverse
Moderate potential for geoarchaeological and palaeoenvironmental remains	Low to Medium	High locally (excavation for retaining walls and station box) but not in terns of the broader	Minor Adverse

Heritage Asset	Sensitivity	Magnitude of Change	Significance of Effect (prior to mitigation)
		resource anticipated in the surrounding area	
Moderate potential for agricultural remains of the medieval to post-medieval periods.	Low/Very Low	High - preparatory groundworks and excavation for retaining walls and station box	Minor Adverse
Low potential for remains dating to the prehistoric and Roman periods	Uncertain (low to high depending on date, nature, extent and preservation)	High - preparatory groundworks and excavation for retaining walls and station box	Uncertain (possible Moderate to Major Adverse)
Buildings currently on site	Low to medium	High - demolition	Major Adverse
Railway viaduct west of the site; Adrian House and Basil House; Victoria Mansions	Low	Negligible following settlement mitigation	None

Battersea Station

8.99 Works at this station would entail excavation and construction of the station and crossover boxes to c –17.45m OD (c 22.0m below ground level). Overrun tunnels will continue west of the station box beneath Whittington Lodge at Battersea Dogs and Cats Home (BDCH). The following effects have been identified within the site:

- Preparatory groundworks which extend beyond/beneath any modern made ground would truncate or remove entirely any archaeological remains in the area of impact;
- Construction of the conveyor will remove any archaeological remains within the footprint of ground disturbance down to the proposed level: construction of supporting piles will remove any remains within the footprint of each pile;
- Intrusive ground works around 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, if undertaken to a deeper extent than previously, may have an impact of removing any archaeological remains present, removing their significance to negligible;
- Construction of the retaining wall will remove any archaeological remains within its footprint;
- Excavation for the ticket hall, station box and crossover box will remove any archaeological remains within the footprint of the work;
- Structural works to the existing Thames-side jetty have the potential to reduce its significance; it is likely, however, that they would have no effect overall on the significance of BPS;
- The temporary removal of the listed cranes would have no effect on the significance of BPS; and
- Underpinning of Whittington Lodge prior to the construction of the running tunnels will (other than the possibility of incidental damage) prevent adverse construction impacts. Other buildings at the BDCH and adjacent railway structures may require underpinning, with a potential impact on any buried heritage assets.

8.100 Table 8−11 sets out the likely effect upon heritage assets prior to the implementation of a mitigation strategy.

Kennington station

8.101 It is likely that the impact would be limited to the fabric of the station itself. No other heritage assets would be affected. Construction of additional cross passages would involve sensitive restoration and reinstatement of suitable materials during fit out.

Table 8-10 Kennington station - Archaeological and Built Heritage Effects Prior to Mitigation

Heritage Asset	Sensitivity	Magnitude of Change	Significance of Effect (prior to mitigation)
Kennington station	High	Uncertain, possibly moderate or low – i.e. minor impacts to fabric	Uncertain, probably Minor Adverse

Operational Phase

8.102 The physical impacts on archaeological remains would occur during the constructional phase of the NLE (i.e. removal or truncation of the asset during intrusive groundworks, or the impact of mitigation for ground settlement), and no additional effects are anticipated during the operational phase. Similarly, physical impacts on built heritage are assumed to be successfully mitigated by compensation measures for any ground settlement, and again no operational effects are anticipated associated with the NLE.

Mitigation Measures

8.103 Currently no remains of very high sensitivity warranting preservation *in situ* have been identified by this desk-based study. The proposed mitigation strategy is for

archaeological investigation and recording prior to and during development (preservation by record). This strategy will be further developed via site-based assessment (archaeological field evaluation and buildings appraisal). The specifications for such work are normally set out in a site-specific written scheme of investigation. The site-based assessments will then allow the mitigation strategy of preservation by record to be fully scoped and defined. Typical examples of evaluation techniques and mitigation strategy are summarised below, and provided in more details in the Code of Construction Practice (CoCP) in *ES Volume II: Appendix N.*

Table 8-11 Battersea station - Archaeological and Built Heritage Effects Prior to Mitigation

Heritage Asset	Sensitivity	Magnitude of Change	Significance of Effect (prior to mitigation)
Possible remains of the early 20th century railway goods depot and associated buildings	Very Low/Low	High - proposed crossover and station boxes, and underpinning	Minor to Moderate Adverse
Possible remains of the mid to late 19th century reservoir and water works	Low	High - proposed conveyor, crossover and station boxes, and underpinning	Moderate Adverse
Palaeoenvironmental remains	Medium	High locally - proposed works to jetty - but not in terms of the broader resource anticipated in the surrounding area	Major Adverse
Possible prehistoric remains	Uncertain (low to medium depending on date, nature, extent and preservation)	High - proposed crossover and station boxes, dredging and underpinning	Uncertain (possible Moderate to Major Adverse)
Possible remains of Roman and later riverside activity	Uncertain (low to medium depending on date, nature, extent and preservation)	High - proposed works to jetty	Uncertain (possible Moderate to Major Adverse)
Cranes, jetty, intake and outlet chambers associated with BPS	Very High	Low – temporary alteration	Moderate adverse
Railway viaducts east and west of BDCH	Low	Negligible following settlement mitigation	None

8.104 Examples of field evaluation techniques that may be appropriate are archaeological trial trenches, geotechnical and geoarchaeological borehole analysis, appraisal of historic buildings and possibly buried terrain modelling.

8.105 Examples of techniques that may be appropriate for a mitigation strategy of preservation by record (archaeological investigation and recording) include full or sample-based excavation where field evaluation has demonstrated the survival of significant remains; and/or the recording of any historic structures affected by the scheme to an appropriate EH level. There may also be a need for a watching brief during construction for remains of lesser significance or for areas where prior access was not otherwise feasible (e.g. service diversions). The aim would be to complete all mitigation in advance of construction wherever possible, however, any deep alluvial sequences occurring at shaft sites (e.g. the Nine Elms station box) may need to be recorded during construction works.

8.106 It is recommended that the buildings scheduled for demolition at the Nine Elms station site and within Kennington Park, and those part of Kennington Underground Station affected by development, are subject to archaeological standing building recording to an appropriate level (EH Level 1 – 2: drawings, photography and a written record of the building) in advance of the commencement of works.

8.107 The demolition of the lodge will not have an adverse impact upon Kennington Park and therefore will not harm the park's significance as a heritage asset. The possible impact on Whittington Lodge from settlement will be prevented by underpinning as part of the Battersea station development, and no further built heritage mitigation will be required.

8.108 The scope of historic environment mitigation will be agreed with the archaeological advisors for each local planning authority concerned.

Residual Effects

8.109 Adverse effects on buried heritage assets within the NLE route would be removed or reduced to an acceptable level through a programme of investigation and mitigation as set out above and in the CoCP, resulting in negligible residual effects as a result of the NLE. This is summarised in Table 8-12.

Table 8-12 Potential Effect on Asset Sensitivity, Proposed Mitigation and Residual Effect

Significance of Effect on Asset Sensitivity	Proposed Mitigation Method	Residual Effect
Construction Phase		
Battersea Station		
Uncertain (minor to major) adverse) - possible remains of prehistoric and later riverside activity, and palaeoenvironmental remains	Preservation by record: Sampling (paleoenvironmental remains) Targeted archaeological excavation and/ or a watching brief (archaeological remains)	**Negligible**
Minor adverse - possible remains of the early 20th century goods depot and associated buildings	Preservation by record: Archaeological watching brief	**Negligible**
Minor adverse - possible remains of the 19th century reservoir and water works	Preservation by record	**Negligible**
Uncertain (minor to major adverse) - possible prehistoric remains	Preservation by record: Targeted archaeological excavation and/or a watching brief as the station box is excavated downwards	**Negligible**
Moderate adverse – alteration of cranes, jetty and intake and outlet chambers	Reinstatement following use: Archaeological standing building recording to EH Level 1 – 2	**Negligible**
Nine Elms Station		
Major adverse – demolition of buildings currently on site	Preservation by record: Archaeological standing building recording to EH Level 1 – 2	**Negligible**
Minor adverse - possible remains of the 20th century works	Preservation by record: Archaeological evaluation followed if required by targeted archaeological excavation and/or a watching brief as the station box is excavated downwards	**Negligible**
Minor adverse - possible remains of mid-19th century houses	Archaeological watching brief	
Minor adverse – geo-archaeological and palaeoenvironmental remains	Preservation by record: Archaeological watching brief	**Negligible**
Minor adverse – possible agricultural remains of the medieval to post-medieval periods	Preservation by record: Archaeological watching brief	**Negligible**
Uncertain (minor to major adverse) possible remains dating to the prehistoric and Roman periods	Preservation by record: Archaeological evaluation followed if required by targeted archaeological excavation and/or a watching brief as the station box is excavated downwards	**Negligible**
Vent and Grouting Shafts		
Minor adverse - Possible remains of late 18th century houses (demolished in c. 1940s-60s) on west side of Kennington Green	Preservation by record: Archaeological watching brief	**Negligible**
Minor adverse/ none demolition of *c.*2002 screen structure forming part of the boundary wall at Kennington Green	None required other than the preservation by record for the structure itself. Archaeological standing building recording to EH Level 1	**Negligible**
Minor adverse / none – demolition of 1938 lodge within Grade II registered Kennington Park	None required other than the preservation by record proposed for the lodge itself. Archaeological standing building recording to EH Level 1 – 2, to include adjacent railings	**Negligible**
Minor adverse – possible agricultural remains of the medieval to post-medieval periods at all shaft sites	Preservation by record: Archaeological watching brief	**Negligible**
Uncertain (minor to major	Preservation by record:	**Negligible**

Significance of Effect on Asset Sensitivity	Proposed Mitigation Method	Residual Effect
adverse) possible prehistoric and Roman remains at all shaft sites	Archaeological evaluation followed if required by targeted archaeological excavation and/or a watching brief	
Kennington Underground Station		
Uncertain, probably Minor Adverse	Preservation by record: Archaeological standing building recording to EH Level 1 – 2	**Negligible**
Operational Phase and Completed Development		
Negligible	NA	**Negligible**

Cumulative Effects Assessment

8.110 This section assesses the impact of the NLE in combination with the likely impact on heritage assets arising from the cumulative schemes listed within *Chapter 2: EIA Methodology*. For each of the cumulative schemes the predicted resources are noted, and whether these are shared with the NLE. Where potential shared resources are identified, the significance of potential cumulative effects is discussed below.

8.111 Built heritage physically affected by the NLE comprises:

- Listed cranes and associated structures at BPS jetty;
- Unlisted buildings of the late 19th century (currently occupied by Banham Security Ltd);
- Kennington Underground Station; and
- 1938 lodge at Kennington Park.

8.112 Of the built heritage assets above, 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 beneficia**l, on the assumption that mitigation for both schemes includes publication and dissemination.

8.113 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 significant.

Table 8-13 Buried Heritage Cumulative Impact Assessment

Cumulative Scheme	Known/likely Archaeological Resource	Resource Potentially Shared with Proposed Development
BPS, Wandsworth	Within APA covering the Thames riverside. Possible remains of the late 19th century reservoir and waterworks. Prehistoric and later remains in alluvium, including supporting palaeoenvironmental evidence.	Southwark and Vauxhall Water Works extended across both Power Station and Battersea station sites. Background potential for prehistoric and later remains shared with Battersea station (jetty and conveyor only)
Wah Kwong House, 10 Albert Embankment	Within APZ. Possible remains of prehistoric to medieval riverside activity and post-medieval development	Partial potential (prehistoric alluvium shared with Battersea station (jetty and conveyor only)
1 Glyn Street, Lambeth	Background potential for archaeological remains of all periods on the Terrace Gravel	Non-specific background potential not directly associated with any NLE site
Riverlight, Tideway Industrial Estate	Within APA covering the Thames riverside. Prehistoric and later remains in alluvium, including supporting palaeoenvironmental evidence, and post-medieval industrialisation, wharves etc	All potential shared with Battersea station (jetty and conveyor only)
Hampton House, 20 Albert Embankment	Within APZ. Possible remains of prehistoric to medieval riverside activity and post-medieval development	Partial potential (prehistoric alluvium shared with Battersea station (jetty and conveyor only)
St George Wharf and Vauxhall Tower	Within APZ. Possible remains of prehistoric to medieval riverside activity and post-medieval development	Partial potential (prehistoric alluvium shared with Battersea station (jetty and conveyor only)
Kennington Oval	Background potential for archaeological remains of all periods on the Terrace Gravel	Non-specific background potential not directly associated with any NLE site

Cumulative Scheme	Known/likely Archaeological Resource	Resource Potentially Shared with Proposed Development
Parliament House, 81, Black Prince Road	Background potential for archaeological remains of all periods on the Terrace Gravel	Non-specific background potential not directly associated with any NLE site
Land on south side of Nine Elms Lane incorporating Ponton Road (US Embassy)	Within APA covering the Thames riverside and Battersea Channel. Possible remains of 19th century industrial archaeology including gasworks and/or railway. Prehistoric and later remains in alluvium, including supporting palaeoenvironmental evidence.	Partial potential (prehistoric alluvium shared with Battersea station (jetty and conveyor only)
Embassy Gardens, land to south of Nine Elms Lane comprising DHL Depot and 1-12 Ponton Road and 51 Nine Elms Lane	Within APA covering the Thames riverside and Battersea Channel. Possible remains of 19th century industrial archaeology including gasworks and/or railway. Prehistoric and later remains in alluvium, including supporting palaeoenvironmental evidence.	Partial potential (prehistoric alluvium shared with Battersea station (jetty and conveyor only)
Vauxhall Sky Gardens (143–161 Wandsworth Road)	Background potential for archaeological remains of all periods on the Terrace Gravel	Non-specific background potential, but within study area close to Nine Elms station site
Thames Tunnel, Kirtling Street Worksite	Within APA covering the Thames riverside. Prehistoric and later remains in alluvium, including supporting palaeoenvironmental evidence, and post-medieval industrialisation, wharves etc	All potential shared with Battersea station (jetty and conveyor only)
Post Office Depot, South London Mail Centre, Nine Elms Lane (Parkside)	Within APA covering the Thames riverside and Battersea Channel. Possible remains of 19th century industrial archaeology including gasworks and/or railway. Prehistoric and later remains in alluvium, including supporting palaeoenvironmental evidence.	Partial potential (prehistoric alluvium shared with Battersea station (jetty and conveyor only)
New Covent Garden Market	Within APA covering the Thames riverside and Battersea Channel. Possible remains of 19th century industrial archaeology including gasworks and/or railway. Prehistoric and later remains in alluvium, including supporting palaeoenvironmental evidence.	Partial potential (prehistoric alluvium shared with Battersea station (jetty and conveyor only)
Sainsbury's 62, Wandsworth Road London	Background potential for archaeological remains of all periods on the Terrace Gravel. 19th century railway goods depot and marshalling yard.	Railway archaeology is a shared asset.
Eastbury House 30–34, Albert Embankment	Within APZ. Possible remains of prehistoric to medieval riverside activity and post-medieval development	Partial potential (prehistoric alluvium shared with Battersea station (jetty and conveyor only)
8, Albert Embankment, London Fire Brigade Headquarters	Within APZ. Possible remains of prehistoric to medieval riverside activity and post-medieval development	Partial potential (prehistoric alluvium shared with Battersea station (jetty and conveyor only)

Cumulative Scheme	Known/likely Archaeological Resource	Resource Potentially Shared with Proposed Development
Island Site Vauxhall Cross	Within APZ. Possible remains of prehistoric to medieval riverside activity and post-medieval development	Partial potential (prehistoric alluvium shared with Battersea station (jetty and conveyor only)
CLS Vauxhall Square	Within APZ. Possible remains of prehistoric to medieval riverside activity and post-medieval development	Partial potential (prehistoric alluvium shared with Battersea station (jetty and conveyor only)
30-60 South Lambeth Road	Bordering APZ. Background potential for archaeological remains of all periods on the Terrace Gravel	Non-specific background potential not directly associated with any NLE site
Spring Mews, Vauxhall Walk	Background potential for archaeological remains of all periods on the Terrace Gravel	Non-specific background potential not directly associated with any NLE site
Battersea Plant, Nine Elms Lane Goods Yard, Cringle Street	Within APA covering the Thames riverside. Prehistoric and later remains in alluvium, including supporting palaeoenvironmental evidence, and post-medieval industrialisation, wharves etc	All potential shared with Battersea station (jetty and conveyor only)
Nine Elms Pier	Within APA covering the Thames riverside. Prehistoric and later remains in alluvium, including supporting palaeoenvironmental evidence, and post-medieval industrialisation, wharves etc	All potential shared with Battersea station (jetty and conveyor only)
Marco Polo House, 346, Queenstown Road	Within APA covering the Thames riverside. General background potential for prehistoric and later rural land use on edge of Battersea eyot	General topographic environment shared with Battersea station and Nine Elms station
Market Towers	Within APA covering the Thames riverside and Battersea Channel. Possible remains of 19th-century industrial archaeology including railway. Prehistoric and later remains in alluvium, including supporting palaeoenvironmental evidence.	Partial potential (prehistoric alluvium shared with Battersea station (jetty and conveyor only)
1-9, Bondway and 4-6, South Lambeth Place	Within APZ. Possible remains of prehistoric to medieval riverside activity and post-medieval development	Partial potential (prehistoric alluvium shared with Battersea station (jetty and conveyor only)

8.114 There is one known buried heritage asset shared between the BPS 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 BPS. Therefore, the additional proposed construction of Battersea station is not considered a significant cumulative effect on the overall asset as it currently survives.

8.115 Cumulatively, 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 of anything found.

8.116 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.

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Ref. 8-9 London Borough of Lambeth (2011); Lambeth Local Development Framework, Core Strategy

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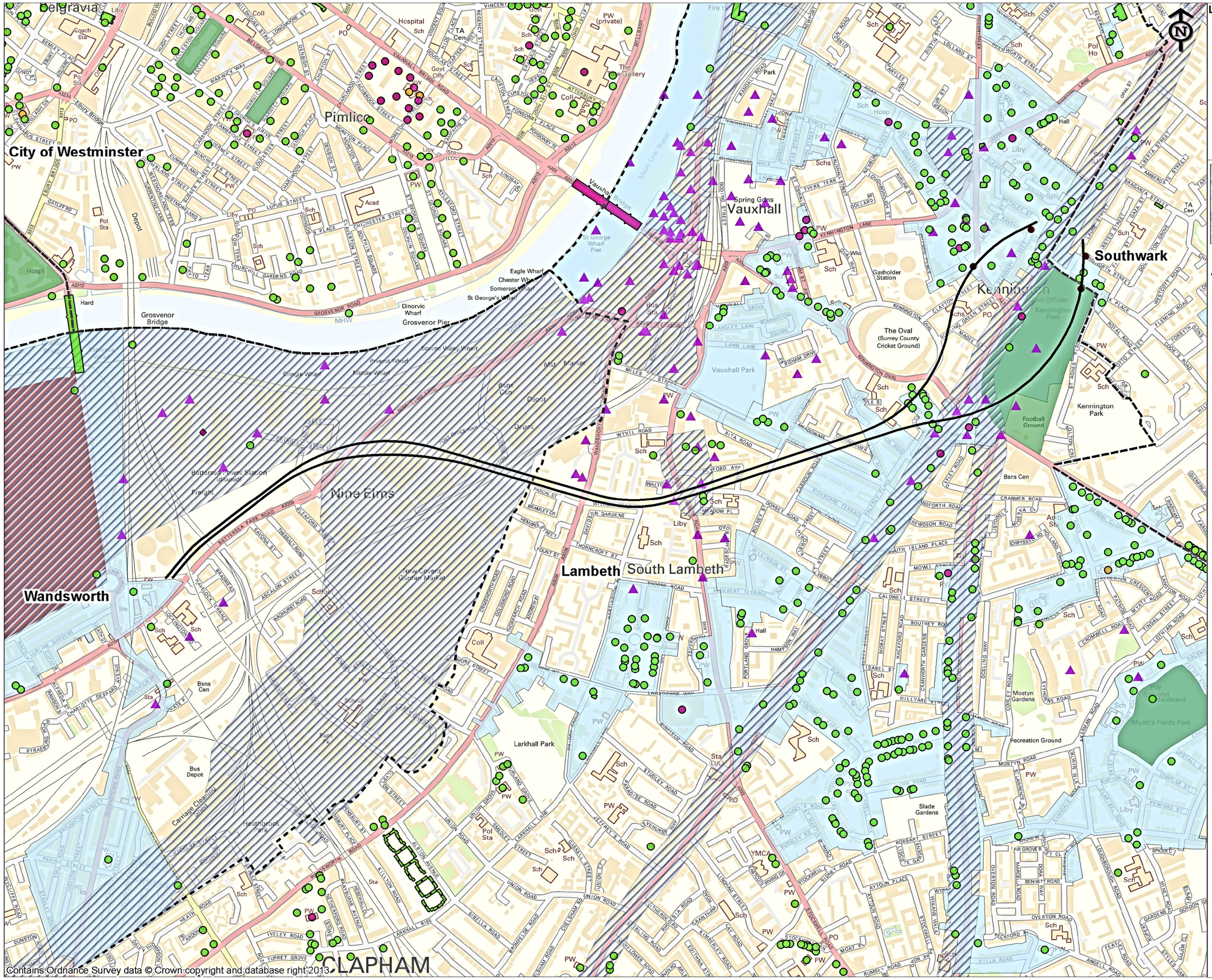
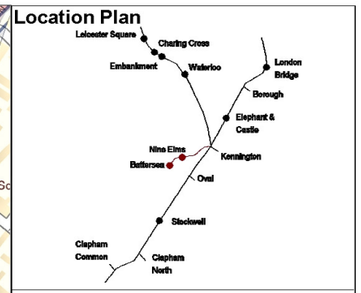
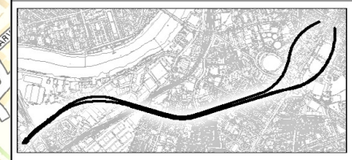


Location Plan





Key:

- Track Alignment
- Borough Boundary

Listed Buildings

- & Grade I
- & Grade II*
- & Grade II

Historic Parks and Gardens

- Grade I
- Grade II*

Listed Buildings

- Known Archaeology Find Spots
- Archaeology Priority Areas
- Conservation Areas

Client:

Transport for London

URS

MUSEUM OF LONDON ARCHAEOLOGY

Project:

NORTHERN LINE EXTENSION
TO BATTERSEA
TWAO FOR TfL

Drawing:

LISTED BUILDINGS,
ARCHAEOLOGY
AND BUILT HERITAGE

Suitability:			
S4	FORMAL ISSUE TO CLIENT		
Drawn by:	DT	Date:	04/03/2013
Checked by:	TW	Date:	04/03/2013
Approved by:	HW	Date:	04/03/2013
Drawing Scale:	1:10,000 @ A3		
Drawing No:	Figure 8-1	Revision:	01

Northbound Kennington Grouting Worksite

Kennington Station

Southbound Kennington Grouting Worksite

Distillery Water Tank

Northbound Kennington Ventilation Shaft and Worksite

Southbound Kennington Ventilation Shaft and Worksite

Battersea Station

Nine Elms Station

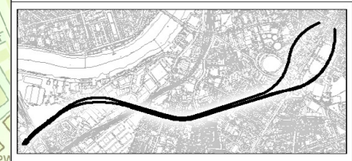
The Thames

Battersea eyot

Battersea Channel

Terrace Gravels

Location Plan



Key:

- Study Area
- Worksite Boundary
- Track Alignment
- Borough Boundary
- Alluvium
- Kempton Park Gravel Formation
- Langley Silt Formation
- Taplow Gravel Formation

Client:

Transport for London

URS

MUSEUM OF LONDON ARCHAEOLOGY

Project:

NORTHERN LINE EXTENSION TO BATTERSEA TWAO FOR TfL

Drawing:

GEOLOGICAL MAP OF THE STUDY AREA

Suitability: S4	FORMAL ISSUE TO CLIENT		
Drawn by:	DT	Date:	04/03/2013
Checked by:	TW	Date:	04/03/2013
Approved by:	HW	Date:	04/03/2013
Drawing Scale:	1:10,000 @ A3		
Drawing No:	Figure 8-2	Revision:	01

09 Noise and Vibration

Environmental Statement

Volume I

09 Noise and Vibration

Introduction

9.1 This chapter of the Environmental Statement (ES) assesses the likely significant effects of the NLE with respect to noise and vibration.

9.2 It describes the methods used to assess the potential impacts associated with the NLE, the baseline conditions existing currently along the route alignment and in the surrounding area, the mitigation measures required to prevent, reduce or offset the magnitude of any adverse impacts, and the likely residual effects after these measures have been adopted.

9.3 The potential for impacts has been considered during both the construction phases and on completion and operation of the NLE. In particular, the chapter considers potential impacts on identified receptors, in terms of:

- Predicted noise and vibration levels from construction works;
- Noise associated with the NLE during operation of ventilation shafts and stations;
- Groundborne noise and vibration associated with the operation of trains on the NLE; and
- Any changes to road traffic noise attributed to the NLE.

9.4 This chapter has been produced by URS Infrastructure and Environment UK Limited (URS) and endorsed by Rupert Taylor Ltd, renowned experts in underground rail noise and vibration assessment. Supporting technical assessments and information are provided within the appendices in *ES Volume II*:

- *E1 Baseline Noise Survey Report;*
- *E2 Construction Noise and Vibration Prediction Report;*
- *E3 Ventilation Shaft and Station Noise and Vibration Prediction Report; and*
- *E4 Groundborne Noise and Vibration Prediction Report.*

Noise and Vibration Terminology

9.5 For the purposes of this chapter, the following terminology and abbreviations are used:

- dB(A) – The unit of noise measurement that approximates the loudness in terms of decibels (dB) based on a weighting factor for humans sensitivity to sound (A);
- Hz – Hertz the unit of frequency;
- L_{A10}, L_{A90} – A-weighted sound pressure level exceeded for 10 or 90 % of the measured time;
- L_{Aeq} – Equivalent continuous A-weighted sound pressure level over a given period of time;
- L_{Amax} – The maximum value that the A-weighted averaged sound pressure level reaches during a measurement period. L_{AFmax}, or Fast, indicates that the sound pressure level is calculated including a 0.125 second time constant.
- VDV – Vibration Dose Values in metres per second$^{1.75}$ (m/s$^{1.75}$). The VDV is given by the fourth root of the time integral of the fourth power of the acceleration after it has been frequency-weighted;
- ppv – peak particle velocity in millimetres per second (mm/s). The vibration measurement parameter that is usually used to describe vibration in relation to sudden impulse events;
- L_w – Sound Power Level;
- L_p – Sound Pressure Level; and
- Free-field noise levels - levels which are at least 3.5 m away from any hard reflecting surface other than the ground.

9.6 Where decibel (dB(A)) levels are followed by a given noise indicator (e.g. L_{Aeq}), then the annotation will read as dB L_{Aeq}.

Planning Policy Context

National Planning Policy

National Planning Policy Framework

9.7 The National Planning Policy Framework (NPPF) (Ref. 9-1) was published on 27th March 2012. The document sets out the Government's planning policies for England and how these are expected to be applied. As a result of the Framework, the following noise related policy and guidance have been withdrawn:

- Planning Policy Statement (PPS) 23: Planning and Pollution Control (Ref. 9-2); and
- Planning Policy Guidance (PPG) 24: Planning and Noise (Ref. 9-3).

9.8 The planning system is required to contribute to and enhance the natural and local environment. Consequently, the aim is to prevent both new and existing development from contributing to or being put at unacceptable risk from, or being adversely affected by unacceptable levels of noise pollution.

9.9 Therefore planning policies and decisions should aim to:

- Avoid noise from giving rise to significant adverse effects on health and quality of life as a result of new development;
- Mitigate and reduce to a minimum other adverse impacts on quality of life arising from noise from new development, including through the use of conditions;
- Recognise that development will often create some noise and existing businesses wanting to develop in continuance of their business should not have unreasonable restrictions put on them because of changes in nearby land uses since they were established; and
- Identify and protect areas of tranquillity which have remained relatively undisturbed by noise and are prized for their recreational and amenity value for this reason.

Noise Policy Statement for England (2010)

9.10 The Noise Policy Statement for England (NPSE) (Ref. 9-4) seeks to clarify the underlying principles and aims in existing policy documents, legislation and

guidance that relate to noise. The statement applies to all forms of noise, including environmental noise, neighbour noise and neighbourhood noise.

9.11 The statement sets out the long term vision of the government's noise policy, which is to "promote good health and a good quality of life through the effective management of noise within the context of policy on sustainable development".

9.12 The NPSE promotes the effective management and control of noise, within the context of Government policy on sustainable development and thereby aims to:

- Avoid significant adverse effects on health and quality of life;
- Mitigate and minimise adverse impacts on health and quality of life; and
- Where possible, contribute to the improvements of health and quality of life.

9.13 The NPSE adopts established concepts from toxicology that are currently being applied to noise impacts. The concept details noise levels, at which the effects of an exposure may be classified into a specific category. The classification categories as detailed within NPSE are as follows:

- No Observed Effect Level (NOEL) - the level below which no effect can be detected. Below this level no detectable effect on health and quality of life due to noise can be established;
- Lowest Observable Adverse Effect Level (LOAEL) - the level above which adverse effects on health and quality of life can be detected; and
- Significant Observed Adverse Effect Level (SOAEL) - the level above which significant adverse effects on health and quality of life occur.

9.14 It is recognised that SOAEL does not have a single objective noise-based level that is applicable to all sources of noise in all situations and therefore the SOAEL is likely to be different for different sources, receptors and at different times of the day.

9.15 The first aim of the NPSE is to avoid significant adverse effects on health and quality of life, taking into account the guiding principles of sustainable development. The second aim considers situations where impacts are established between the LOAEL and SOAEL. In such circumstances, all reasonable steps should be taken to mitigate and minimise the effects. However this does not mean that such adverse effects cannot occur. The third aim seeks to improve health and quality of life, where possible, through the pro-active management of noise, whilst also taking account of the guiding principles of sustainable development.

9.16 The Department for Environment, Food and Rural Affairs (DEFRA) has commissioned a research contract to identify the SOAEL and LOAEL for a limited range of noise sources. No guidance from this research has been issued at the time of writing.

Local Planning Policy

London Borough of Southwark

9.17 The London Borough of Southwark (LBS) Local Development Framework Core Strategy (2011) (Ref. 9-5), with specific reference to noise, Strategic Policy 13 'High Environmental Standards' of the Local Development Framework (LDF) Core Strategy states the following:

> *"Setting high standards and supporting measures for reducing air, land, water, noise and light pollution and avoiding amenity and environmental problems that affect how we enjoy the environment in which we live and work. This includes making sure developments are designed to cope with climate conditions as they change during the development's lifetime."*

9.18 The LBS Environmental Code of Construction Practice (ECCP) (Ref. 9-6) sets out the procedures for managing the environmental impact of construction works, including noise and vibration impacts, and provides guidance for monitoring regimes, noise and vibration limits.

London Borough of Lambeth

9.19 The London Borough of Lambeth's (LBL) Core Strategy (2011) (Ref. 9-7) does not contain any policies specifically in relation to noise or vibration. Instead reference is made to the relevant policies detailed in The London Plan: Spatial Development Strategy for Greater London, July 2011.

9.20 The LBL's Code of Practice for Construction Sites (CoPCS) (Ref. 9-8), sets out the procedures for managing the environmental impact of construction works including noise and vibration effects, and specifies the following hours of working:

- 0800 – 1800 Monday to Friday;
- 0800 – 1300 Saturday.

9.21 LBL does not have a specific noise standard for construction works but provides guidance for assessing noise effects and expects contractors to use 'best practicable means' to minimise noise.

London Borough of Wandsworth

9.22 The London Borough of Wandsworth (LBW) Core Strategy (2010) (Ref. 9-9) states the following:

> *"Noise pollution can have a harmful effect on people's health and well-being. It is an increasing problem in Wandsworth as much of the borough's area is distinctly urban in character resulting in many different causes of noise pollution."*

9.23 It goes on to say:

> *"The Council is committed to reducing all forms of noise pollution in the borough in line with the Mayor's Ambient Noise Strategy and detailed policies to address the need to lower noise pollution will be set out in the Development Management Policies Document."*

9.24 The LBW Local development Framework (LDF) (2008) (Ref. 9-10) Development Management Policies Document, Policy DMS 1, states that:

> *"Planning permission will be granted for developments which comply with the following criteria where relevant, it does not harm the amenity of occupiers/users and nearby properties through unacceptable noise, vibration, traffic congestion, air pollution, overshadowing, overbearing, unsatisfactory outlook, privacy or sunlight/daylight."*

9.25 The LBW's CoPCS (Ref. 9-11) sets out the procedures that aim to reduce the impact of construction work on local communities, including the noise and vibration effects of works and specific hours of working. It suggests that where residential

occupiers are likely to be affected by noise, the hours of noisy works shall normally be restricted to:

- Monday to Friday: 0800 – 1800;
- Saturday: 0800 – 1300; and
- Sunday and Bank holidays: No noisy activities on site.

British Standards

British Standard 7445

9.26 British Standard BS 7445-2:1991 'Description and Measurement of Environmental Noise' (Ref. 9-12) defines parameters, procedures and instrumentation required for environmental noise measurement and analysis.

British Standard 6472

9.27 British Standard 6472-1 'Guide to Evaluation of Human Exposure to Vibration in Buildings Part 1: Vibration Sources other than Blasting' (Ref. 9-13) presents recommended frequency weighted vibration spectra (for continuous vibration) and vibration dose values (VDV) (for intermittent vibration) above which adverse comment is likely to occur in residential properties.

British Standard 5228

9.28 British Standard 5228 'Noise and Vibration Control on Construction and Open sites' (Ref. 9-14) provides a 'best practice' guide for noise and vibration control, and includes sound power level (Lw) data for individual plant as well as a calculation method for noise from construction activities. Note that while the 2009 edition is the current standard, the withdrawn 1997 version remains the Standard approved by the Secretary of State pursuant to Section 71 of the Control of Pollution Act 1974.

British Standard 7385

9.29 British Standard 7385 'Evaluation and Measurement for Vibration in Buildings' (Ref. 9-15) presents guide values or limits for transient vibration, above which there is a likelihood of cosmetic damage.

British Standard 4142

9.30 British Standard 4142 'Method for Rating Industrial Noise Affecting Mixed Residential and Industrial Areas' (Ref. 9-16) can be used for assessing the impact of noise from mechanical services plant. The method is based on a comparison of the difference between 'Rating Level' of the new noise, with the 'Background Level' at the receptor position.

British Standard 14837

9.31 British Standard 14837 'Mechanical vibration – Groundborne noise and vibration arising from rail systems' (Ref. 9-17) provides general guidance on groundborne vibration generated by the operation of railways, and the resultant groundborne noise in buildings.

Legislation, Standards and Guidance

Control of Pollution Act

9.32 The Control of Pollution Act (CoPA) (1974) (Ref. 9-18) 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.

9.33 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 to apply for prior consent to operate construction sites under noise levels and working hours 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. A local authority does not have to grant Section 61 consent if it does not find the terms of the Section 61 application sufficient to protect sensitive receptors. The powers under Section 60 and Section 61 apply to surface construction sites and activities only.

Calculation of Road Traffic Noise

9.34 Department of Transport (DfT) / Welsh Office Memorandum 'Calculation of Road Traffic Noise (CRTN)' (Ref. 9-19) describes procedures for traffic noise calculation, and is suitable for environmental assessments of schemes where road traffic noise effects occur.

Design Manual for Road and Bridges

9.35 The Highways Agency 'Design Manual for Road and Bridges Volume 11 Section 3 Part 7-Traffic Noise and Vibration' (DMRB) (2011) (Ref. 9-20) 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.

International Standard 9613

9.36 International Standard (ISO 9613): 'Attenuation of sound during propagation outdoors', (Ref. 9-21) describes a method for calculating the attenuation of sound during propagation outdoors in order to predict the levels of environmental noise at a distance from a variety of sources.

Noise and Vibration Asset Design Guidance

9.37 The Transport for London/London Underground Guidance Document G1323 Noise and Vibration Asset Design Guidance (2012) (Ref. 9-22) defines noise and vibration assessment methodologies and criteria that should be used in the design and construction of new operational assets.

NLE Code of Construction Practice

9.38 The Northern Line Extension (NLE) Code of Construction Practice (CoCP), (2013), (*ES Volume II: Appendix N*) 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.

Measurement and Assessment of Groundborne Noise & Vibration

9.39 The Association of Noise Consultants (ANC) guidelines on Measurement and Assessment of Groundborne Noise and Vibration (2011) (Ref. 9-23) provides a method for predicting structure-borne noise in buildings resulting from trains in tunnels.

Assessment Methodology and Significance Criteria

9.40 This section presents the methodology used to assess each type of noise and vibration effect, in terms of the application of relevant standards and guidance (as detailed above), the types of data and analyses carried out, and the derivation of the presented impact or compliance criteria used in the assessments.

Description of Impacts and Effects

9.41 The following terminology has been used in the ES to define effects:

- **Adverse** – detrimental or negative effect to an environmental resource or receptor;
- **Negligible** – imperceptible effects to an environmental resource or receptor; or
- **Beneficial** – advantageous or positive effect to an environmental resource or receptor.

9.42 Where adverse or beneficial impacts have been identified, these have been assessed against the following scale:

- **Low** – slight, very short or highly localised effect of no significant consequence;
- **Medium** – limited effect (by extent, duration or magnitude), which may be considered significant; or
- **High** – considerable effect (by extent, duration or magnitude) of more than a local impact or in breach of recognised acceptability, legislation, policy or standards.

9.43 The significance of the effect has been considered based on the magnitude of the impact and the sensitivity of the receptor, as shown in Table 9-1.

Table 9-1 Significance of Effects

		Sensitivity of Receptor		
		High	**Medium**	**Low**
Magnitude of Impact	**High**	Major	Moderate	Minor
	Medium	Moderate	Minor	Minor
	Low	Minor	Minor	Negligible
	Negligible	Negligible	Negligible	Negligible

9.44 High sensitivity receptors are considered to be residential buildings, hospitals, and places of worship. Medium sensitivity receptors are considered to be offices and commercial buildings. Low sensitivity receptors are considered to be buildings of an industrial nature.

9.45 Due to the nature of the buildings that surround the locations affected by the construction and operation of the NLE, this chapter will concentrate on high sensitivity receptors since those are located close to the locations of all works and are the most affected by the construction and operation of the scheme. Therefore, the significance criteria for each section of the assessment will be based on high sensitivity receptors.

Construction Noise and Vibration

Construction Noise and Vibration Prediction Methodology

9.46 The noise levels generated by construction activities and experienced by nearby sensitive receptors, such as the occupants of residential properties, depend upon a number of variables, the most significant of which are:

- the noise generated by plant or equipment used on site, generally expressed as a sound power level (L_w);
- the periods of operation of the plant on the site, known as its 'on-time';
- the distance between the noise source and the receptor; and
- the attenuation due to ground absorption and barrier effects.

9.47 Construction noise predictions contained in the assessment are based on the methodology outlined in British Standard BS 5228-1:2009 'Noise and vibration control on construction and open sites'.

9.48 BS 5228-1:2009 contains a database of the noise emission from individual items of equipment, activities and routines to predict noise from construction activities at identified receptors. The prediction method gives guidance on the effects of different types of ground, barrier attenuation and how to assess the impact of fixed and mobile plant.

9.49 In order to evaluate the noise from construction, it is necessary to define the various activities to be undertaken and the equipment to be used, based upon the anticipated programme of work. A programme of the anticipated construction works and the various items of plant that are likely to be required for each activity (refer to *Chapter 4: Description of the NLE* of this ES) has been developed to inform the assessment. This has been used to enable estimates of the likely construction noise levels to be made, in accordance with the BS 5228-1:2009 methodology.

9.50 The highest levels of noise will arise from the six surface construction sites. However, the construction of the tunnels will give rise to groundborne noise that may be audible inside properties above the route of the proposed scheme. The prediction of groundborne noise from the construction of the tunnels has been taken from the prediction method outlined in BS 5228-2:2009.

9.51 Further details of the construction noise prediction methodology are provided in *ES Volume II: Appendix E2* Construction Noise and Vibration Prediction Report.

Construction Noise Significance

9.52 Significance criteria for construction noise have been derived from BS 5228-1:2009 guidance. The criteria are based on the total noise level due to construction of the

railway (pre-existing ambient plus airborne NLE construction noise), predicted at a point one metre in front of the most exposed of any windows and doors in any façade of a noise sensitive building.

9.53 The predicted construction noise levels have been assessed using the 'ABC Method' provided in BS 5228-1:2009. Table 9-2 presents the ABC method given in BS 5228-1:2009.

Table 9-2 Construction Noise Thresholds

Assessment Category and Threshold Value Period	Threshold Value dB(A)		
	Category A [a)]	Category B [b)]	Category C [c)]
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.			

9.54 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.

9.55 While for operational effects significance comes in a range of magnitudes, the significance of effect in the construction assessment is presented as binary (either significant or non-significant), as there is no scientific basis for attaching magnitudes in excess of significance thresholds. If the total noise level exceeds the Threshold Value, then a significant effect is assessed.

Construction Traffic Noise Prediction Methodology

9.56 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 NLE, following the methodology given in the CRTN.

Construction Traffic Noise Significance

9.57 Construction traffic noise has been assessed by considering the short-term increase in traffic flows during works, following the principles of CRTN and DMRB.

9.58 The criteria for the assessment of traffic noise changes arising from construction works have been taken from Table 3.1 of DMRB. The sensitivity of the receptors must be taken into account when determining the significance of the impact. The NLE is situated in predominantly residential areas and as such the receptor sensitivity has been assumed to be high in all cases. Table 9-3 presents the criteria set out in DMRB and the associated significance for the development.

Table 9-3 Road Traffic Noise Assessment Criteria

Noise Change Band (dB(A)	Magnitude of Impact as Given in DMRB	Significance of Effect for the NLE
0	No change	No change
0.1 – 0.9	Negligible	Negligible
1 – 2.9	Minor	Minor
3 – 4.9	Moderate	Moderate
5	Major	Major

9.59 Buildings that are considered to be of high sensitivity are residential properties, hotels, places of worship and theatres. Commercial premises are considered to be of low sensitivity.

Construction Vibration

9.60 There are no accepted formulae for the prediction of the passage of vibration through ground due to the non-uniform effects of different ground conditions, although some empirical formulae have been proposed for known ground conditions based on previously measured data.

9.61 There are several construction activities that have the potential to give rise to vibration and groundborne noise. These are:

- construction of structure foundations;
- use of Tunnel Boring Machines (TBMs); and
- operation of the temporary construction railway.

9.62 For the effects due to construction vibration, the vibration peak particle velocity (ppv) has been calculated at sensitive receptors using example measured source data and the propagation relationship taken from BS 5228-2:2009.

9.63 For the use of tunnel boring machines, the prediction has been undertaken using the empirical relationship provided in BS 5228-2:2009. This Standard gives guidance on the method to be used to predict ground vibration levels due to TBMs

and also gives an empirical relationship that can be used for the estimation of groundborne noise due to TBMs.

9.64 The prediction of vibration from the construction railway has been undertaken using the same methodology as for the prediction of operational groundborne noise and vibration.

Construction Vibration Effects on Humans

9.65 Guidance on the human response to vibration is provided in BS 5228-2:2009. This guidance has been translated into the significance criteria in Table 9-4 and is adapted from Table B.1 in BS 5228-2:2009.

Table 9-4 Guidance On Human Effects Of Construction 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 Adverse
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 Adverse
>10 mm/s	Vibration is likely to be intolerable for any more than a very brief exposure to this level.	Major Adverse

9.66 The vibration levels are provided in terms of peak particle velocity (ppv).

Construction Vibration Effects on Buildings

9.67 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.

9.68 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 9-5. These criteria have been taken from Table 1 of BS 7385-2:1993.

9.69 Where the vibration excitation is continuous, the values in Table 9-5 are required to be halved.

9.70 Vibration exceeding the values shown above in Table 9-5 would be considered a significant adverse effect. It should be noted that the criteria used in this assessment relate to the potential for cosmetic damage rather than damage to structural elements of buildings.

Table 9-5 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 of 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.

Operational Noise and Vibration

9.71 The operation of the NLE has the potential to produce noise and vibration effects due to two primary sources, namely:

- groundborne noise and vibration from underground rail traffic; and
- noise due to fixed plant and equipment from ventilation shafts and stations.

9.72 Both of these sources are assessed in detail as part of this chapter.

Operational Groundborne Noise and Vibration Prediction Methodology

9.73 The prediction of vibration 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. Such phenomena are impossible to foresee.

9.74 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 primarily empirical. Mathematical modelling is used to support the predictions where the use of empirical modelling is not possible.

9.75 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, although it predates modern rail support

systems and incorporates no vibration isolation, it has similar depth and ground conditions to the proposed NLE route.

9.76 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.

9.77 An example of these measurement positions with respect to the underground line is presented in Figure 9-1.

9.78 The measurement data gathered at these positions have been used within a URS prediction model that enables the noise and vibration from the proposed NLE to be predicted. The measurements at the ground surface have been used to define how the vibration decays with distance from the tunnel alignment. The use of this decay with distance allows the prediction of vibration at any distance from the proposed alignment of the NLE. This prediction model has been validated using Rupert Taylor's Findwave® model.

9.79 The full methodology of the groundborne noise and vibration prediction is presented in the *ES Volume II: Appendix E4* Groundborne Noise and Vibration Prediction Report.

Groundborne Vibration Significance Criteria

9.80 The assessment of vibration affecting humans in buildings is made in accordance with BS 6472-1:2008 by considering the Vibration Dose Value (VDV) in $m/s^{1.75}$. The VDV levels take into account both the level and duration of vibration events, allowing both continuous and intermittent vibration events to be assessed using the same assessment metric.

9.81 The significance of vibration was derived from BS 6472-1:2008, which rates vibration in terms of varying degrees of adverse comment, ranging from 'adverse comment not expected' to 'adverse comment very likely'. This range of varying degrees of adverse comment has been translated into the significance criteria presented in Table 9-6.

Figure 9-1 Diagram of Groundborne Noise and Vibration Propagation

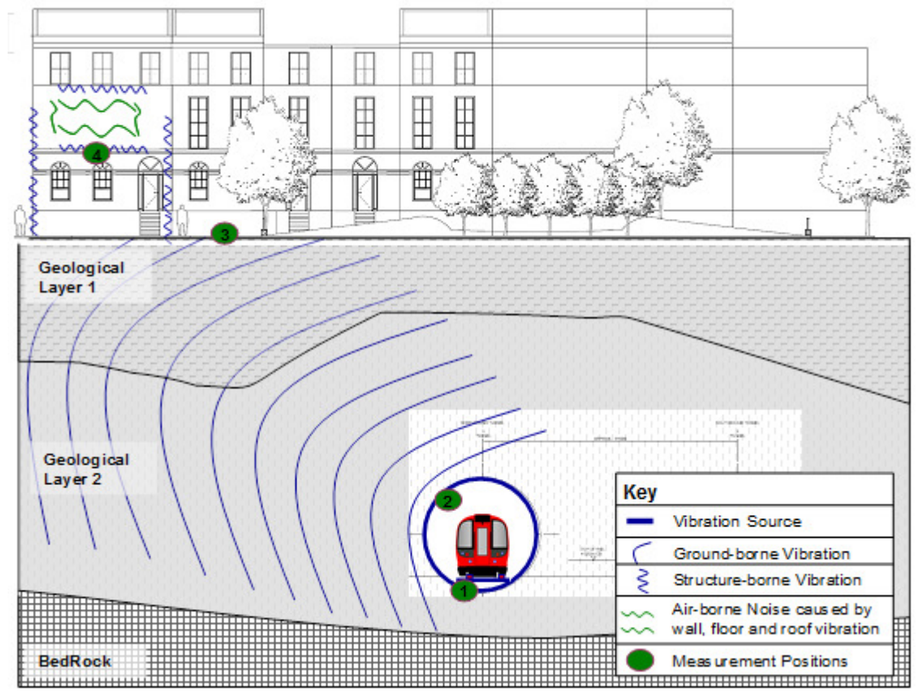


Table 9-6 Criteria for Assessing Human Response to Vibration in Buildings

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

9.82 The values shown in Table 9-6 relate to residential accommodation and are also used for hotels and places of worship. Where the assessment concerns the effects on commercial premises, the values shown in Table 9-6 need to be doubled, as advised by BS 6472-1:2008.

9.83 The building damage criteria presented in Table 9-5 are also applicable to operational vibration. As such, vibration levels experienced at the structure which exceed the values shown in Table 9-5 would be considered to be a significant

effect. It should be noted that the criteria used in this assessment relate to the potential for cosmetic damage rather than damage to structural elements of buildings.

Groundborne Noise Significance Criteria

9.84 There are no UK legislative standards or criteria that define when groundborne noise becomes significant. The groundborne noise criteria are based upon LUL guidance and the precedent set by recent sub surface and underground projects such as Crossrail, East London Line, Thameslink and the Jubilee Line Extension.

9.85 The criteria used in this assessment for operational groundborne noise are given in Table 9-7.

Table 9-7 Significance of Groundborne Noise Effects

Internal* Noise Level Due to a Train Passby (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.

9.86 The groundborne noise criteria from the NLE have been compared with the following London rail projects

- Jubilee Line Extension (Approved 1992);
- High Speed 1 (Approved 2005);
- Thameslink (Approved 2006); and
- Crossrail (Approved 2008)

9.87 A comparison between the criteria used on these projects and the NLE is given in *ES Volume II: Appendix E4*. The most significant findings of this report are that the NLE has a lower target level for operational groundborne noise and vibration than previous large-scale UK rail projects.

Ventilation Shaft and Station Noise Prediction Methodology

9.88 The NLE will provide two new stations at Nine Elms and Battersea. The operation of the NLE will require the construction of two ventilation shafts at Kennington Green and Kennington Park. These stations and ventilation shafts will incorporate plant and equipment that have the potential to generate noise effects at surrounding residential properties.

9.89 Full details of the ventilation shaft and station noise assessment is presented in *ES Volume II: Appendix E3* Ventilation Shaft and Station Noise Assessment Report.

Ventilation Shaft and Station Noise Significance Criteria

9.90 The assessment of the effects of ventilation shaft and station noise on residential buildings has been based on the methodology detailed in BS 4142:1997. This methodology is commonly used for the assessment of fixed plant, such as fans, generators, cooling units etc.

9.91 The basis of the standard is a comparison between the background noise level in the vicinity of receptor 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 - $L_{Aeq,Tr}$ - the equivalent continuous 'A' weighted sound pressure level of the source in question over a given time interval Tr;
- Rating Level – $L_{Ar,Tr}$ - 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.

9.92 Once any adjustments have been made, the background and the rating noise levels are compared. The standard states that the greater the difference, the greater the likelihood of complaints. The Standard gives the following guidance when assessing the effects of industrial noise on residential properties:

- "A difference of around +10 dB or more (rating above background) indicates that complaints are likely;
- A difference of around +5 dB is of marginal significance;
- If the rating level is more than 10 dB below the measured background level, this is a positive indication that complaints are unlikely."

9.93 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.

9.94 Significance criteria for operational noise have been derived from BS 4142:1997. A semantic scale for the description of the operational noise impacts is presented in Table 9-8.

Table 9-8 Significance Criteria For Ventilation Shaft and Station Noise

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

Summary Prediction Methodologies and Significance Criteria

9.95 To provide a concise summary of this section, Table 9-9 presents a brief description of the prediction methods and criteria that have been used to predict and quantify the potential effects of the NLE.

Table 9-9 Summary of Noise and Vibration Prediction Methodologies and Significance Criteria

Potential Source of Noise and Vibration	Prediction Method	Source of Significance Criteria
Construction Noise and Vibration	Methodology contained in BS 5228-1:2009 and BS 5228-2:2009	BS 5228-1:2009, BS 5228-2:2009 and NLE Code of Construction Practice
Construction Traffic Noise	Methodology contained in BS 5228-1:2009 and 'Calculation of Road Traffic Noise'	The Design Manual for Roads and Bridges
Operational Groundborne Noise and Vibration	Empirical vibration modelling and verification using FINDWAVE®	2012 LUL design guidance
Ventilation Shaft and Station Noise	CadnaA noise mapping software, using ISO 9613 prediction methodology	Guidance given in BS 4142:1997

Baseline Conditions

9.96 A number of environmental noise surveys were undertaken to establish the baseline conditions at key noise sensitive receptor locations. These locations represent the sites that are potentially affected by noise from the six surface sites during the construction and operational phases of the scheme. These include the Kennington Green and Kennington Park ventilation shafts, Nine Elms station and Battersea station.

9.97 The noise surveys consisted of a combination of short term and long term monitoring. Long-term unattended noise monitoring was carried out at each of the ventilation shaft and station sites between April 2008 and September 2010.

9.98 To provide additional noise data at key receptor locations, further short term noise surveys were undertaken in January and March 2013. These consisted of a series of 10 minute measurements during the daytime, and a series of 5 minute measurements during the night-time.

9.99 For each of the surveys average ambient (L_{Aeq}) and background (L_{A90}) noise levels were obtained. An overview of the environmental noise survey locations is shown in Figure 9-2 attached.

9.100 The survey locations and the full results of the baseline noise surveys are presented in the *ES Volume II: Appendix E1* Northern Line Extension Baseline Noise Survey Report. A description of survey locations and survey dates is given in Table 9-10.

In Property Noise and Vibration Surveys

9.101 To provide source data for use in the detailed groundborne noise and vibration modelling used in the operational assessment, existing groundborne noise levels in properties close to the Northern and Victoria lines were used. The most relevant data to provide as a baseline were measurements undertaken at 27 Albert Square in October 2012.

9.102 This property is located close to the Victoria line between Stockwell and Vauxhall stations. The Victoria line at this location is representative of the shallowest depth at which NLE will be constructed and runs through similar geology. The southbound Victoria line is approximately 12 m from the property and the northbound Victoria line is approximately 40 m from the property. Therefore, the groundborne noise levels measured within this property are expected to be representative of the levels that should occur from the NLE for the unmitigated case. The full results of these measurements are included within *ES Volume II: Appendix E4* Groundborne Noise and Vibration Prediction report.

Baseline Environmental Survey Results

9.103 Full results of the baseline noise survey are provided in *ES Volume II: Appendix E1* NLE Baseline Noise Survey report. This provides details of the surveys undertaken and the prevailing weather conditions during all measurements.

Battersea Station

9.104 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.

9.105 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.

9.106 A summary of long- and short-term noise measurements for the day and night periods are presented in Table 9-11.

Table 9-10 Noise Monitoring Locations

Location	Survey Date	Description
L1	25 April to 9 May 2008	North of Battersea Park Road and directly east of train line
L2	25 April to 9 May 2008	North of Battersea Park Road
L3	27 July to 3 August 2010	Corner of Pascal Street and Wandsworth Road
L4	3 to 13 August 2010	St Agnes Place
L5	9 to 14 September 2010	Kennington Green (Kennington Road)
S1	5 to 6 March 2013	South of Battersea Park Road
S2	5 to 6 March 2013	South of Battersea Park Road
S3	5 to 6 March 2013	South of Battersea Park Road
S4	5 to 6 March 2013	Pascal Street
S5	15 January 2013	Bramley Crescent
S6	15 January 2013	Wilcox Road
S7	5 to 6 March 2013	Kennington Park Place
S8	5 to 6 March 2013	Corner of St Agnes Place and Royal Road
S9	5 to 6 March 2013	Corner of Harmsworth Street and Faunce Street
S10	5 to 6 March 2013	Corner of Radcot Street and Ravendson Street
S11	5 to 6 March 2013	Cleaver Square
S12	5 to 6 March 2013	Kennington Road
S13	5 to 6 March 2013	Kennington Road
S14	5 to 6 March 2013	Corner of Kennington Park Road and Kennington Park Place

Table 9-11 Summary of Battersea Station Noise Monitoring Results

Location	Average Ambient Free-Field dB $L_{Aeq,T}$			Lowest Hourly Recorded Background Noise dB $L_{A90,T}$	
	Daytime (0700 – 1900) and Saturdays (0700 – 1300)	Evenings (1900 – 2300) and Weekends	Night (2300 – 0700)	Daytime	Night-time
				0700 – 2300 (T = 16hr)	2300 – 0700 (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 LA90 for each day and each night period

9.107 The measured day and night time levels captured by the long-term measurements differ from the short-term measurements by 10 – 14 dB this is a direct result of the location of the measurement positions. All short-term positions were in close proximity to Battersea Park Road while the long-term monitors are set back into the site away from the road.

Nine Elms Station

9.108 Long-term noise measurements (L3) in July and August 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.

9.109 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 the CGMA site.

9.110 A summary of the noise measurements for the day and night periods are presented in Table 9-12.

Table 9-12 Summary of Nine Elms Station Noise Monitoring Results

Location	Average Ambient Free-Field dB $L_{Aeq,T}$			Lowest Hourly Recorded Background Noise dB $L_{A90,T}$	
	Daytime (0700 – 1900) and Saturdays (0700 – 1300)	Evenings (1900 – 2300) and Weekends	Night (2300 – 0700)	Daytime	Night-time
				0700 – 2300 (T = 16hr)	2300 – 0700 (T = 8hr)
L3	59	59	52	47*	44*
S4	55	53	50	43	38
S5	58	-	-	44	-
S6	65	-	-	53	-
* Represents lowest hourly average LA90 for each day and each night period					

Kennington Park

9.111 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 of the proposed Kennington Park ventilation shaft site.

9.112 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.

9.113 A summary of long-term and short-term noise measurements for the day and night periods are presented in Table 9-13.

Kennington Green

9.114 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 proposed Kennington Green ventilation shaft site.

9.115 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.

9.116 A summary of long- and short-term noise measurements for the day and night periods are presented in Table 9-14.

Table 9-13 Summary of Kennington Park Noise Monitoring Results

Location	Average Ambient Free-Field dB $L_{Aeq,T}$			Lowest Hourly Recorded Background Noise dB $L_{A90,T}$	
	Daytime (0700 – 1900) and Saturdays (0700 – 1300)	Evenings (1900 – 2300) and Weekends	Night (2300 – 0700)	Daytime	Night-time
				0700 – 2300 (T = 16hr)	2300 – 0700 (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					

Table 9-14 Summary of Kennington Green Noise Monitoring Results

Location	Average Ambient Free-Field dB $L_{Aeq,T}$			Lowest Hourly Recorded Background Noise dB $L_{A90,5min}$	
	Daytime (0700 – 1900) and Saturdays (0700 – 1300)	Evenings (1900 – 2300) and Weekends	Night (2300 – 0700)	Daytime	Night-time
				0700 – 2300 (T = 16hr)	2300 – 0700 (T = 8hr)
L5	71	63	61	51*	39*
S12	71	-	65	57	43
S13	73	-	66	61	46
* Represents lowest hourly average LA90 for each day and each night period					

Harmsworth Street

9.117 Short-term noise measurements (S9) in March 2013 were carried out in the proximity of the proposed Harmsworth Street temporary shaft site.

9.118 The noise environment at the measurement locations is dominated by road traffic noise from local roads. Other significant noise sources include overhead aircraft movements.

9.119 A summary the short-term noise measurements for the day and night periods are presented Table 9-15.

Table 9-15 Summary of Harmsworth Street Noise Monitoring Results

Location	Average Ambient Free-Field dB $L_{Aeq,T}$			Lowest Hourly Recorded Background Noise, dB $L_{A90,5min}$	
	Daytime (0700 – 1900) and Saturdays (0700 – 1300)	Evenings (1900 – 2300) and Weekends	Night (2300 – 0700)	Daytime	Night-time
				0700 – 2300 (T = 16hr)	2300 – 0700 (T = 8hr)
S9	66	-	56	54	43

Radcot Street

9.120 Short-term noise measurements (S10 and S11) in March 2013 were carried out in the proximity of the proposed Harmsworth Road Grouting Shaft site.

9.121 The noise environment at the measurement locations is dominated by road traffic noise from local roads. Other significant noise sources include overhead aircraft movements. A summary the short-term noise measurements for the day and night periods are presented in Table 9-16.

Table 9-16 Summary of Radcot Street Noise Monitoring Results

Location	Average Ambient Free-Field dB $L_{Aeq,T}$			Lowest Recorded Background Noise dB $L_{A90,5min}$	
	Daytime (0700 – 1900) and Saturdays (0700 – 1300)	Evenings (1900 – 2300) and Weekends	Night (2300 – 0700)	Daytime	Night-time
				0700 – 2300 (T = 16hr)	2300 – 0700 (T = 8hr)
S10	56	46	48	41	36
S11	65	-	53	49	36

In Property Groundborne Noise Measurements

9.122 The data acquired inside properties have been analysed to determine typical groundborne noise levels. These levels are typical for the trains that travel on the Northern line and have been determined from the distribution of levels across all measured pass-bys.

9.123 The measured groundborne noise levels during the passage of trains on the Victoria line within 27 Albert Square were typically 37 dB L_{AFmax} for the northbound track and typically 42 dB L_{AFmax} for the southbound track. These levels can be considered to be similar to those that may occur from the NLE for the unmitigated situation.

9.124 The full results of the baseline groundborne noise and vibration surveys are presented in the *ES Volume II: Appendix E4* Groundborne Noise and Vibration Prediction Report.

Environmental Impacts and Significance of Effects

Construction

Noise from Surface Construction Sites

9.125 Two construction options are under consideration for this project. Option A includes two temporary shaft sites for compensation grouting and tunnel boring plant removal at the end of the construction phase. In Option B the TBM will finish at the ventilation shaft sites and the final length of tunnel boring will be undertaken manually with a spray concrete lining applied. Option A represents the worst-case scenario (as it includes the two additional work sites) and has been assessed below.

9.126 Construction noise predictions have been completed for each of the six surface construction sites required for Option A:

- Battersea station;
- Nine Elms station;
- Kennington Park ventilation and intervention shaft;
- Kennington Green ventilation and intervention shaft;
- Harmsworth Street temporary grouting shaft; and
- Radcot Street temporary grouting shaft.

9.127 As detailed in Table 9-2, the construction noise assessment criteria have been determined using the ABC method as set out in BS 5228-1:2009, as such the criteria for each construction site is dependent upon the ambient noise levels measured during the baseline survey. The construction noise assessment threshold values for each of the six sites are provided in Table 9-17. The threshold values have been determined based upon the most sensitive receptors using the lowest measured ambient noise level for each period. The monitoring locations used to define the threshold values are provided against each area.

9.128 Predictions of the construction noise levels from surface construction activities have been undertaken in accordance with the methodology outlined in BS 5228-1:2009. The detailed calculations are provided in *ES Volume II: Appendix E2*. No mitigation (such as site hoarding) has been included within the acoustic simulations. The results of the construction assessment are summarised for each site below.

9.129 The surface construction activities (excluding the excavated material removal) will only routinely take place during normal daytime hours, as set out in the CoCP, which is provided in *ES Volume II: Appendix N*. Therefore, unless otherwise stated, predicted noise levels relate to daytime operation only. Any works outside the daytime hours will be subject to a separate approval from the relevant authorities.

Table 9-17 Construction Noise Assessment Threshold Values

	Construction noise Threshold Values dB $L_{Aeq,T}$		
	Daytime (0700 – 1900) and Saturdays (0700 – 1300)	**Evenings (1900 – 2300) and Weekends**	**Night (2300 – 0700)**
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 Park – *Kennington Park Place (L4)*	75	65	64
Kennington Park – *St Agnes Place (S8)*	65	60	55
Kennington Green *(L5, S12, S13)*	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 9-2 have been assumed.

Station Sites

9.130 Based upon the works, shown in *Chapter 4: Description of the NLE*, it is considered that the noisiest activities for the construction of the new stations will occur during the early phases of the construction programme. The key construction phases are:

- enabling works – including concrete breaking and diaphragm-walling (approximate duration 1 year);
- tunnel enabling works/station box structure – including station box excavation (approximate duration 1 year); and
- night time excavated material removal (Battersea only approximate duration 1 year).

Battersea Station

9.131 Table 9-18 below summarises the predicted construction noise levels at the nearest sensitive receptors for the Battersea station construction site for the above phases. The receptor locations are illustrated in Figure 9-3 attached.

Table 9-18 Predicted Construction Noise Levels for Battersea Station

	Highest predicted construction façade noise levels L_{Aeq} (dB)		
	Enabling Works	**Tunnel Enabling Works and Station Box Structure**	**Night time Excavated Material Removal**
Bat 1 - 75 Battersea Park Road	43	65	54
Bat 2 - 85 Battersea Park Road	47	70	58
Bat 3 – 101 Battersea Park Road	44	68	55
Bat 4 – 101a Battersea Park Road	43	68	55

9.132 The predicted noise levels from construction activities at Battersea station are within the threshold values set out in Table 9-17. Therefore, the effect of construction noise at the identified sensitive receptors will not be significant (negligible to minor adverse) during the daytime, evening or nighttime periods.

9.133 The excavated material will be removed from the Battersea site by barge. The barges will be loaded via the existing jetty to the north of the Battersea Park site. The closest sensitive receptor will be the residential block which forms phase 1 of the Battersea Park redevelopment. Noise levels associated with the jetty construction activities (piling and dredging) and the loading activities have been predicted to reach 71 dB L_{Aeq} and 61 dB L_{Aeq} respectively. As the development has yet to be commenced, the ambient noise levels at the receptor cannot be determined; therefore, the lowest threshold values have been used to assess the significance of construction noise.

9.134 The predicted noise levels from the jetty construction activities exceed the threshold values and represent a potentially significant (moderate to major adverse) effect; however, the anticipated duration is expected to be short. The loading activities will be below the threshold values during the day but exceed threshold values for the evening and night. The model does not include the consideration of the screening provided by any site hoarding.

Nine Elms Station

9.135 Table 9-19 below summarises the predicted construction noise levels at the nearest sensitive receptors for the Nine Elms Station construction site for the above phases. The receptor locations are illustrated in Figure 9-4 attached.

Table 9-19 Predicted Construction Noise Level for Nine Elms Station

	Highest predicted construction noise levels L_{Aeq} (dB)	
	Enabling Works (including concrete breaking)	**Tunnel enabling Works and Station Box Structure**
Nine 1 – 47 Pascal Street	80	74
Nine 2 – 38 Bramley Crescent	76	73
Nine 3 - Charman House	78	76
Nine 4 - Adrian House	71	73

9.136 The predicted noise levels from construction activities at Nine Elms station are above the criteria set out in Table 9-17 and represent a significant (moderate to major adverse) effect at all receptors.

9.137 The predicted noise levels represent the likely worst case during the early phases of construction. This will represent a small proportion of the overall construction schedule, currently less than 20 % of the total construction duration. It is anticipated that once excavation of the station box has begun and the plant that produce the majority of the noise are no longer at the surface, the noise levels will reduce to a point where they no longer represent a significant (negligible to minor adverse) effect.

Ventilation and Intervention Shafts

9.138 The key noise generating activities for the ventilation and intervention shafts will occur during the site preparation and shaft excavation phases of the construction programme (approximate duration 10 weeks). Existing buildings located on the proposed shaft sites will be demolished as part of the enabling works. The duration of these activities will be sufficiently brief that no significant effects (negligible to minor adverse) are expected.

9.139 Predictions of the noise generated during the shaft excavation phase have been undertaken for both sites. This represents a worst-case assessment.

Kennington Park

9.140 Table 9-20 below summarises the predicted construction noise levels at the nearest sensitive receptors for the Kennington Park ventilation and intervention shaft construction site during shaft excavation. The receptor locations are illustrated in Figure 9-5 attached.

9.141 The predicted noise levels at all receptors are above the threshold values set out in Table 9-17 and are considered significant (moderate to major adverse).

Table 9-20 Predicted Construction Noise Levels for Kennington Park Shaft

	Highest predicted construction noise levels L_{Aeq} (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

Kennington Green

9.142 Table 9-21 below summarises the predicted construction noise levels at the nearest sensitive receptors for the Kennington Green shaft construction site during shaft excavation. The receptor locations are illustrated in Figure 9-6 attached.

Table 9-21 Predicted Construction Noise Levels Kennington Green Shaft

	Highest predicted construction noise levels L_{Aeq} (dB)
Green 1 – 350 Kennington Road	79
Green 2 – 41 Kennington Road	72
Green 3 - 381 Kennington Road	73
Green 4 - 149 Kennington Road	72
Green 5 – 364 Kennington Road	74

9.143 The predicted construction noise levels at receptor location Green 1 exceeds the limits set out in Table 9-17. This represents a significant impact at this receptor location. All other receptor locations are within the criteria and are not subject to levels of construction noise considered to be significant (moderate to major adverse). 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.

Temporary Shafts

9.144 There are two distinct phases associated with the construction of the temporary shaft sites; namely shaft excavation and grouting operation which last five weeks

and 62 weeks respectively. The grouting operation will not be continuous over the 62 week period, activities will occur on a demand basis.

9.145 Predictions of the noise generated during the shaft excavation and grouting phases have been undertaken for both sites. These represent worst-case assessments.

Harmsworth Street

9.146 Table 9-22 below summarises the predicted construction noise levels at the nearest sensitive receptors for the Harmsworth Street temporary shaft construction site during shaft excavation and grouting operation. The receptor locations are illustrated in Figure 9-6 attached.

Table 9-22 Predicted Construction Noise Levels Harmsworth Street Temporary Shaft

	Highest predicted construction noise levels L_{Aeq} (dB)	
	Shaft Excavation	**Grouting operation**
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

9.147 The predicted noise levels from shaft excavation activities at the Harmsworth Street construction site are all above the noise criteria set out in Table 9-17. This represents a significant (moderate to major adverse) effect at all identified receptors.

9.148 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 (moderate to major adverse) effect, however it should be noted that the operation of the grouting plant will be based upon demand and will not be continuous.

Radcot Street

9.149 Table 9-23 below summarises the predicted construction noise levels at the nearest sensitive receptors for the Radcot Street temporary shaft construction site during shaft excavation and grouting operation. The receptor locations are illustrated in Figure 9-7 attached.

Table 9-23 Predicted Construction Noise Levels for Radcot Street Temporary Shaft

	Highest predicted construction noise levels L_{Aeq} (dB)	
	Shaft Excavation	**Grouting operation**
Rad 1 - 2 Ravensdon Street	79	78
Rad 2 - 5 Ravensdon Street	81	71
Rad 3 - 1 Methley Street	77	75
Rad 4 - 1 Radcot Street	84	74
Rad 5 - 10 Radcot Street	72	70
Rad 6 - 2 Radcot Street	81	75
Rad 7 - 3 Radcot Street	80	76
Rad 8 - 4 Radcot Street	81	78
Rad 9 - 5 Radcot Street	80	78
Rad 10 - 6 Radcot Street	77	75
Rad 11 - 7 Radcot Street	78	76
Rad 12 - 8 Radcot Street	76	74
Rad 13 - 9 Radcot Street	73	71
Rad 14 - 2 Methley Street	74	70

9.150 The predicted construction noise levels for both the construction and grouting phases are above the criteria set out in Table 9-17 for all receptors. This represents a significant (moderate to major adverse) effect at all receptors. However, it should be noted that the use of the grouting plant will be on-demand and will not be a continuous operation.

Traffic Noise

9.151 Based on construction traffic flow data presented in *Chapter 4: Description of the NLE*, changes in 18-hour traffic noise levels have been calculated using methodologies in line with CRTN guidance. Baseline traffic flow data has been provided as part of the traffic assessment (as part of *Chapter 6: Traffic and Transportation* of this ES).

9.152 Table 9-24 presents the results of the construction traffic noise assessment.

Table 9-24 Construction Traffic Noise Assessment

Road	Baseline 18-Hour Traffic Flow		Baseline + Construction 18-Hour Traffic Flow		Predicted Change in Traffic Noise Level, dB $L_{A10,18hr}$	Significance of Effect
	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%	28898	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	35678	9%	35884	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%	22232	10%	**0.4**	Negligible

9.153 In comparison to the traffic noise assessment criteria in Table 9-3 it is predicted that construction road traffic is likely to provide a negligible to minor significance for all assessed road links. The only location where the construction traffic is predicted to provide a minor effect is Wandsworth Road due to the Nine Elms station works.

9.154 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 excavated material 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.

Construction Vibration – Potential Impacts

9.155 BS 5228-2:2009 indicates that construction activities generally only generate vibration impacts when they are located less than 20 m from sensitive locations.

9.156 The station structures will be supported by diaphragm 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 diaphragm walls.

9.157 The closest residential receptors to the Battersea station and Nine Elms station sites are 15 m and 50 m respectively.

9.158 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 diaphragm wall construction. However, it is anticipated that vibration caused by construction of the diaphragm walls will be comparable with levels generated through auger piling. Table 9-25 below details example vibration levels.

Table 9-25 Example Auger Piling Vibration Levels

BS 5228-2:2009 Ref 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

9.159 Based on the example vibration levels in Table 9-25 and the construction works vibration criteria in Table 9-4, potential vibration levels from diaphragm walling affecting nearby human receptors (i.e. occupants of adjacent residential dwellings and office units) are considered to be limited to a minor effect.

9.160 With reference to the BS 7385-2:1993, expected vibration levels from construction activities are below the thresholds for cosmetic damage to structures (i.e. on-site structures to be retained, surrounding structures). As such, it is predicted that the likelihood of any cosmetic damage to the on-site structures due to vibration from surface construction works will be negligible.

Noise and Vibration from Underground Construction Works

9.161 The railway tunnels between the existing Northern line loop at Kennington station and Battersea Power Station will be constructed using TBMs. This method can give rise to groundborne noise and vibration that may affect properties above the route alignment.

9.162 The prediction of groundborne 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 groundborne noise and vibration given the distance from the tunnel excavations to the assessment location.

9.163 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 groundborne vibration levels that can be expected due to TBMs are provided in Table 9-26.

9.164 The expected groundborne noise levels from the use of TBMs have been predicted using the empirical methods provided in BS 5228-2:2009. The use of this method has allowed the groundborne noise levels from the use of TBMs to be predicted at the selected receptors along the route. These receptors have been mapped in Figure E4-1 in *ES Volume II: Appendix E4*. The results of these predictions are provided in Table 9-26. The predictions were undertaken for use of the TBM with no mitigation in place.

9.165 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 9-4 and Table 9-5, it can be seen that the significance of construction vibration from TBMs is negligible for both the effects on buildings and humans.

9.166 The worst-case groundborne noise level for underground tunnelling activities is predicted to be 57 dB L_{pA}. 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 groundborne noise level drops to 49 dB L_{pA}. It should be noted that these noise levels are predicted in terms of L_{pA}, rather than the L_{AFmax} used in the significance criteria and due to the method used in the prediction method, the predicted L_{pA} is compared to the L_{AFmax} criteria.

Table 9-26 Predicted Groundborne Noise and Vibration Levels from TBM without mitigation

Receptor	Predicted ppv, mm/s	Predicted Groundborne Noise Level, dB L_{pA}
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

9.167 The data used in the formulation of the prediction method given in BS 5228-2:2009 were gathered on ground types that are different to the London Clay through which the majority of the NLE tunnels will be constructed. London Clay is a relatively soft material and the data used in BS 5228-2:2009 prediction method include those for hard rock geologies, which may overestimate groundborne noise levels for softer ground conditions. To support this section of the chapter, data have been provided by Crossrail (Ref. 9-26) from recent measurements of groundborne noise produced by the tunnel boring carried out for Crossrail. These data are for a similar tunnel depth through comparable ground conditions to the NLE, so it is expected that groundborne noise levels are likely to be comparable.

9.168 The results of the Crossrail measurements show that measured groundborne noise levels are 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.

9.169 The conclusion of the Crossrail report was that groundborne 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 groundborne noise from TBM use during construction of the tunnels will be minor adverse.

Temporary Construction Railway

9.170 The removal of excavated material and delivery of construction materials will be achieved using a combination of conveyors and a temporary construction railway. This railway will be used to transport material to and from the workforce.

9.171 The design of the construction railway will be the responsibility of the contractor and as such, it is not possible to assess this element of the construction in any detail. However, due to the temporary nature of this installation, it is not common practice to install significant levels of resilience into the track. Therefore, it is likely that groundborne noise levels will be of the order of those predicted for the unmitigated operational groundborne noise. Therefore, the effects of the operation of the construction railway are likely to be similar to those for the unmitigated operational noise. A detailed assessment of the unmitigated trackform is included in the following section of this chapter.

Operation

Groundborne Noise and Vibration from Trains

9.172 Empirical modelling has been used to predict the groundborne vibration levels that are expected to occur along the route. The measurements of surface vibration have been combined with typical vibration transfer functions to account for the transfer of vibration from the ground into buildings. This allows the prediction of vibration at the point of entry into the human body, as required by BS 6472-1:2008. The predicted vibration levels are for a single train pass by. These are combined with the number of events expected based on the 2031 service frequency of 28 trains per hour in each direction. These have allowed the prediction of the Vibration Dose Values for the day and night. The predicted groundborne vibration levels at the selected receptors are provided in Table 9-27.

Table 9-27 Predicted Vibration Dose Values From Trains

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, Wilcox Close, Vauxhall	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

9.173 The results provided in Table 9-27 show that for all receptors, the daytime vibration dose values are rated by BS 6472-1:2008 as ‘adverse comment not expected’. The night time Vibration Dose Values are rated by BS 6472-1:2008 as being of ‘low probability of adverse comment’ at one of the chosen receptor locations.

Therefore, the operational groundborne vibration levels from trains are expected to provide a negligible to minor adverse effect.

9.174 The groundborne vibration levels that have been predicted on the floors of the properties along the route have been used to predict the groundborne noise levels at varying distances from the track. These distances have been mapped in a series of figures that are provided in *ES Volume II: Appendix E4*. In addition, the groundborne noise levels have been predicted at selected receptors. These results are presented in Table 9-28.

Table 9-28 Predicted Groundborne Noise Levels from Trains

Receptor	Groundborne Noise Level, dB L_{AFmax}
Adrian House, Wandsworth Road	38
Mawbey Brough Health Centre, Wilcox Close, Vauxhall	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

9.175 The table above and figures in *ES Volume II: Appendix E4* show that groundborne noise levels are predicted to be up to 38 dB L_{AFmax}. at locations immediately adjacent to the tunnel alignment. The alignment of the tunnels is such that groundborne noise levels of this magnitude are predicted to occur for properties above much of the route between Kennington and Nine Elms stations. The two locations where the levels are greater than 38 dB :L_{AFmax} are the locations close to the step plate junctions, where the junctions are expected to increase levels to no more than 45 dB L_{AFmax}. There are currently no identified groundborne noise sensitive buildings between Nine Elms and Battersea stations. Therefore, when these levels are compared with the significance criteria in Table 9-7, it can be seen that the significance of operational groundborne noise levels is moderate adverse.

Noise from Ventilation Shafts and Stations

9.176 There is one ventilation shaft to be located at Kennington Green and one at Kennington Park. There are also ventilation shafts planned to be installed at Nine Elms station and the Battersea station.

9.177 For Kennington Green and Kennington Park, the shaft will terminate within ground level head houses 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.

9.178 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.

9.179 It is understood there will be a traction power sub-station located at the Kennington Park head house. There is likely to be other plant associated with the shafts and stations but no details are available at this time.

9.180 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.

9.181 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.

9.182 The design for the tunnel ventilation fans has been done in conjunction with the NLE engineers (Halcrow). The baseline noise surveys have been used to define the current background noise environment for all sites. This has then been combined with the required design target from BS 4142:1997 to define the acceptable noise levels that can occur outside the facades of the closest noise sensitive receptors to each ventilations shaft. The proposed layout of the ventilation shaft has then been used to define a limit on the noise level than can occur at the outlet of the tunnel ventilation system, which have been used as design criteria for the NLE engineers. The design criteria for daytime and night time operational periods are presented in Table 9-29. It should be noted that that these levels are the combination of sound from all fixed installations which affect that receptor location.

9.183 A feasibility study has been undertaken to determine whether the above limits are achievable. The NLE engineers (Halcrow) have provided predictions of the anticipated system attenuation, including silencers, for each of the ventilation shafts. The calculation has demonstrated that the design limits can be achieved with the proposed designs. Full details of the calculation can be found in *ES Volume II: Appendix E3* Ventilation Shaft and Station Noise and Vibration Prediction Report.

Table 9-29 Ventilation Shaft and Station Noise Limit

	Kennington Park	Kennington Green	Nine Elms	Battersea
Typical lowest night time $L_{A90,1hr}$ (dB)	44	39	45	43
Proposed design criteria 5 dB 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

9.184 Since the design criterion is to achieve a rating noise level 5 dB below the Background Noise Level, it is considered that the effects of noise from ventilation shafts and stations is negligible. This design target is 5 dB below the background noise, which is 10 dB below the point at which BS 4142:1997 states that industrial noise is of marginal significance and 10 dB below the point at which it is considered to cause a significant effect in environmental terms.

Mitigation

Construction Noise and Vibration

9.185 Noise and vibration will be managed to reduce effects, and mitigation measures are documented in the projects CoCP. It will be a contractual requirement on the construction contractors to undertake all works in accordance with the project CoCP, which is provided in *ES Volume II: Appendix N*. The CoCP 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.

9.186 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, this is a summary of the mitigation detailed within the CoCP and is not an exhaustive list. There may be other mitigation measures that are applicable and may be used by the contractors.

- 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.

9.187 For use of Conveyors the following measures will be adopted:

- 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.)

9.188 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 groundborne 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.

9.189 In addition to each of the measures listed above, the construction contractors will be required by the CoCP to submit Section 61 applications for all surface works. This will allow the expected noise and vibration effects of the construction works to be controlled by the relevant Local Authority in which the works are being undertaken. 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 7.

9.190 There may be exceptional circumstances where it is not practicable to meet the target construction noise thresholds. In such cases, the project has a Noise Insulation and Temporary Rehousing policy that will provide off-site mitigation to remove any significant residual effects.

Operational Groundborne Noise and Vibration from Trains

9.191 The operational groundborne vibration levels are predicted to provide a minor adverse effect. However, the groundborne noise effects of the railway have been predicted to introduce a moderate adverse effect during the operation of the NLE. Therefore, some form of mitigation is required to reduce the significance of this operational groundborne noise effect.

9.192 The prediction of the groundborne noise and vibration levels from the operation of the NLE have been undertaken using measured data captured from trains operating on the Northern and Victoria lines. The trackforms used at the locations where the source data measurements were taken are standard LUL trackforms. These designs of track have very little resilience within the track system, which means that there is little vibration isolation of the track from the tunnel and surrounding ground.

9.193 The design of modern railway tracks incorporate resilience into the track for a variety of engineering reasons. However, this resilience has a beneficial effect in terms of groundborne noise and vibration. The track to be used in the NLE running tunnels will be a modern trackform that includes some degree of resilience in the system. However, the design of the scheme is such that the final trackform has not been selected. Current procurement arrangements are such that 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 provides the same vibration performance as the system of resilient baseplates installed on the Jubilee Line Extension (JLE) and the diversion of the Northern line at London Bridge carried out as part of the JLE project. These baseplates provide a resilient layer underneath the rail baseplate between the baseplate and the concrete track slab.

9.194 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 reduced due to inclusion of the resilient baseplates in the track system. This insertion gain has been applied to the vibration 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 a 10 dB reduction of the overall groundborne noise levels. Many available track systems can provide this level of vibration attenuation.

Operational Noise from Ventilation Shafts and Stations

9.195 The most common form of mitigation for the reduction of noise from ventilation fans and equipment is through the use of careful acoustic design. This design process will allow the specification of attenuators to reduce the noise from equipment as much as practicable. This process will involve an iterative design to select the most effective attenuators in terms of noise reduction, while taking into account the non-acoustic factors such as pressure loss on the fans and the effect on the efficiency of the ventilation regime. In some cases, fan selections may have to be changed to meet the acoustic requirements of the design.

9.196 It is normal design practice for ventilation shafts to be designed with both an atmospheric and system side attenuator. This is to reduce the noise that impacts on the environment and to reduce the noise that is introduced into the tunnels which may escape via other routes, such as draught relief or emergency intervention shafts.

Residual Effects

Construction Noise and Vibration

9.197 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 surface demolition and construction programme and activities will be discussed with the relevant local authorities once a contractor has been commissioned. Such details for all surface demolition and construction activities 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.

9.198 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.

9.199 A number of potential mitigation measures have been recommended that are expected to be implemented during the construction of the NLE to reduce the significant adverse effects identified. These are identified in the CoCP, which is in *ES Volume II: Appendix N*. The appointed contractor will implement suitable mitigation already described, so that significant (moderate to major adverse) noise effects are not experienced during the construction of the NLE.

9.200 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 9-17.

9.201 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. 9-27) 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 is not significant (**negligible to minor adverse**).

9.202 The groundborne noise from the construction railway is predicted to have a maximum noise level of 45 dB L_{AFmax}. The use of the construction railway will be an infrequent event, with only a small number of train movements per day. Due to the infrequency of these events, the significance of the use of the construction railway will be **minor** to **moderate** adverse.

Operational Groundborne Noise and Vibration from Trains

9.203 The effects of the use of a trackform with the same vibration performance as the JLE baseplate system have been introduced into the groundborne vibration modelling and the predicted groundborne vibration levels at the selected chosen receptors are provided in Table 9-30.

Table 9-30 Predicted Mitigated Ground 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, Wilcox Close, Vauxhall	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

9.204 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**.

9.205 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 *ES Volume II: Appendix E4*. These maps show contours of the predicted mitigated groundborne noise. In addition, the groundborne noise levels have been predicted at the selected receptors. These results are presented in Table 9-31.

Table 9-31 Predicted Mitigated Groundborne Noise Levels

Receptor	Groundborne Noise Level, dB L_{AFmax}
Adrian House, Wandsworth Road	27
Mawbey Brough Health Centre, Wilcox Close, Vauxhall	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

9.206 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**.

Operational Noise from Ventilation Shafts and Stations

9.207 All fixed plant and equipment for stations and ventilation shafts will be designed to try and meet a target noise level that is 5 dB below the background noise level. Where this is not possible, best reasonable endeavours will be used to reduce noise levels as much as possible. In all circumstances, noise levels from fixed installations will not be more than 5 dB above the background noise level. Therefore, the use of acoustic design is predicted to reduce the effects to be no more than **negligible**.

Cumulative Effects

9.208 *ES Volume II: Appendix A3* provides details of the developments surrounding the route of the NLE that have the potential to provide cumulative effects with the construction and operation of the NLE.

9.209 During the construction phase, the cumulative developments have the potential to result in cumulative effects due to noise from adjacent surface sites and also from cumulative increases in road traffic.

9.210 There will be no other sources of cumulative groundborne 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 effects.

Cumulative Construction Effects

9.211 There are several identified developments that have the potential to cumulatively affect the construction works related to the NLE. These developments are outlined in *ES Volume II: Appendix A3* Strategy for Cumulative Impact Assessment. There are several of these developments that will occur simultaneously with the NLE surface construction works and have the potential to cumulatively impact on the works from the NLE sites.

9.212 At this stage in the development process, there is not sufficient detail to allow a full cumulative assessment to be carried out. Such an assessment would require detailed construction noise calculations of the same form and for the same locations as those for the NLE.

9.213 To avoid cumulative effects from surface construction works, the construction contractors should ensure that any potential cumulative noise and vibration effects are considered when carrying out detailed construction noise and vibration assessments.

Cumulative Construction Traffic Effects

9.214 *ES Volume II: Appendix A3* contains details of the cumulative construction traffic that can be expected from all the identified cumulative developments. The data are provided in terms of expected vehicles flows for each three month period that the NLE construction works will be carried out. However, these data cover only total volume of construction traffic and not the flow for each road link. Therefore, there is not sufficient detail to allow the prediction of the cumulative road traffic noise effects to be carried out.

Conclusion and Summary

9.215 A detailed noise and vibration assessment has been carried out of the potential environment effects that may be caused by the construction and operation of the NLE.

9.216 Construction noise from the surface sites is predicted to produce significant (moderate to major adverse) effects for the unmitigated scenarios for receptors close to the construction sites. The predictions have been based on worst-case scenarios and the predicted effects will not occur over the full construction duration. Mitigation measures that will be used to reduce construction noise levels as much as possible are included in the CoCP. The CoCP mandates the use of the Section 61 process to undertake the construction works within the target noise thresholds provided in Table 9-17. Where this is not practicable, the Construction Noise and Vibration Mitigation Scheme will be used to provide off-site mitigation to remove any remaining significant residual effects. Therefore, the residual construction noise effects are **not significant (negligible to minor adverse)**.

9.217 Construction vibration has been predicted for diaphragm walling and tunnel boring activities. The effects of construction vibration are not predicted to be significant for their effects on humans or structures.

9.218 Groundborne noise due to tunnel boring activities is predicted to cause a **minor adverse** effect.

9.219 The operational groundborne vibration levels have been assessed and it is expected that levels will provide a **negligible** effect during the day and a **minor adverse** effect during the night. Therefore, no mitigation is required specifically for operational groundborne vibration.

9.220 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 assessed that a vibration isolating track form is required in the running tunnels. The use of a vibration isolating track form that provides the same degree of isolation as the JLE baseplate system is predicted to reduce the predicted groundborne noise plevels 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. The use of the proposed mitigation meets the design guidance for groundborne noise and vibration.

9.221 The operational noise due to fixed installations at stations and ventilation shafts has been predicted to provide a **negligible** effect with the predicted noise levels no greater than 5 dB below the background noise levels. This meets the project design target.

References

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Ref. 9-3 Department of the Environment/Welsh Office (1994); Planning Policy Guidance 24 – Planning and Noise, TSO, London

Ref. 9-4 Department for Environment Food and Rural Affairs (2010); Noise Policy Statement for England

Ref. 9-5 London Borough of Southwark (2011);Local Development Framework Core Strategy

Ref. 9-6 London Borough of Southwark (2001): Environmental Code of Construction Practice

Ref. 9-7 London Borough of Lambeth (2011); Core Strategy

Ref. 9-8 London Borough of Lambeth (Undated); Code of Practice for Construction Sites

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Ref. 9-10 London Borough of Wandsworth (2012); Local Development Framework

Ref. 9-11 London Borough of Wandsworth (Undated); Code of Practice for Construction Sites

Ref. 9-12 British Standards Institute (1991); BS7445 - Description and Measurement of Environmental Noise. Part 2: Guide to the Acquisition of Data Pertinent to Land Use, BSi, London

Ref. 9-13 British Standards Institute (2008); BS6472 - Guide to Evaluation of Human Exposure to Vibration in Buildings, BSi, London

Ref. 9-14 British Standards Institute (2009); BS5228 - Noise and Vibration Control on Construction and Open Sites, BSi, London

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Ref. 9-17 British Standards Institute (BSi) (2005); BS14837 – Mechanical vibration – Groundborne noise and vibration arising from rail systems, BSi, London

Ref. 9-18 Her Majesty's Stationary Office (1974); Section 72 of the Control of Pollution Act

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Ref. 9-25 Proceedings of Acoustics (2006): Directivity Loss Factor at a Duct Termination

Ref. 9-26 RPS (2013); 1391_TBM_Monitoring_Draft_Report_0-1_- C300/410 Western Tunnels and Caverns, Tunnel Boring Machine Proactive Groundborne Noise and Vibration Monitoring, February 2013

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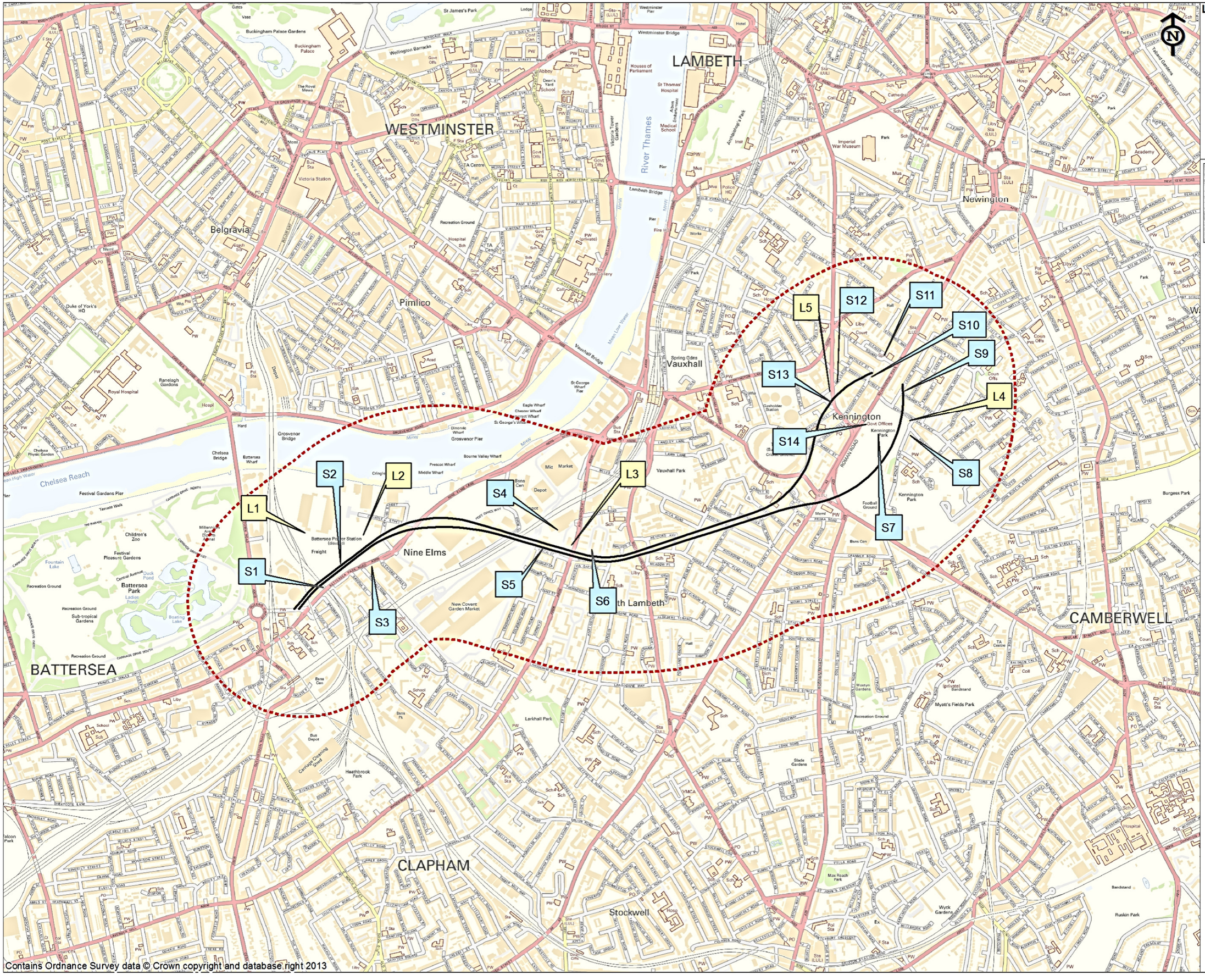

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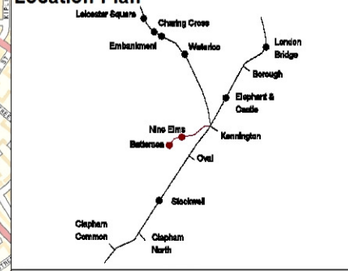

Key:

- Track Alignment
- 500m Buffer
- Attended Short Term Noise Monitoring Positions
- Unattended Long Term (6 day) Noise Monitoring Positions

Client: **Transport for London**

URS

Project: NORTHERN LINE EXTENSION TO BATTERSEA TWAO FOR TfL

Drawing: NOISE MONITORING LOCATIONS

Suitability: S4 FORMAL ISSUE TO CLIENT

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Checked by:	TW	Date:	04/03/2013
Approved by:	HW	Date:	04/03/2013

Drawing Scale: 1:15,000 @ A3

Drawing No: Figure 9-2

Revision: 01

CRINGLE STREET

KIRTLING STREET

BATTERSEA PARK ROAD

SLEAFORD STREET

SAVONA STREET

THESSALY ROAD

BRADMEAD

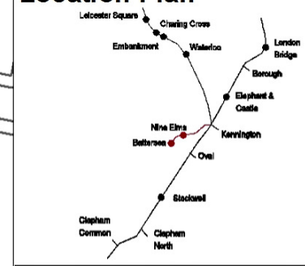
Bat 1

Bat 2

Bat 3

Bat 4

Location Plan



Key:

- Noise Sensitive Receptors
- Indicative Construction Site

Client: **Transport for London**

URS

Project: NORTHERN LINE EXTENSION TO BATTERSEA TWAO FOR TfL

Drawing:

BATTERSEA STATION NOISE SENSITIVE RECEPTORS

Suitability: S4 FORMAL ISSUE TO CLIENT

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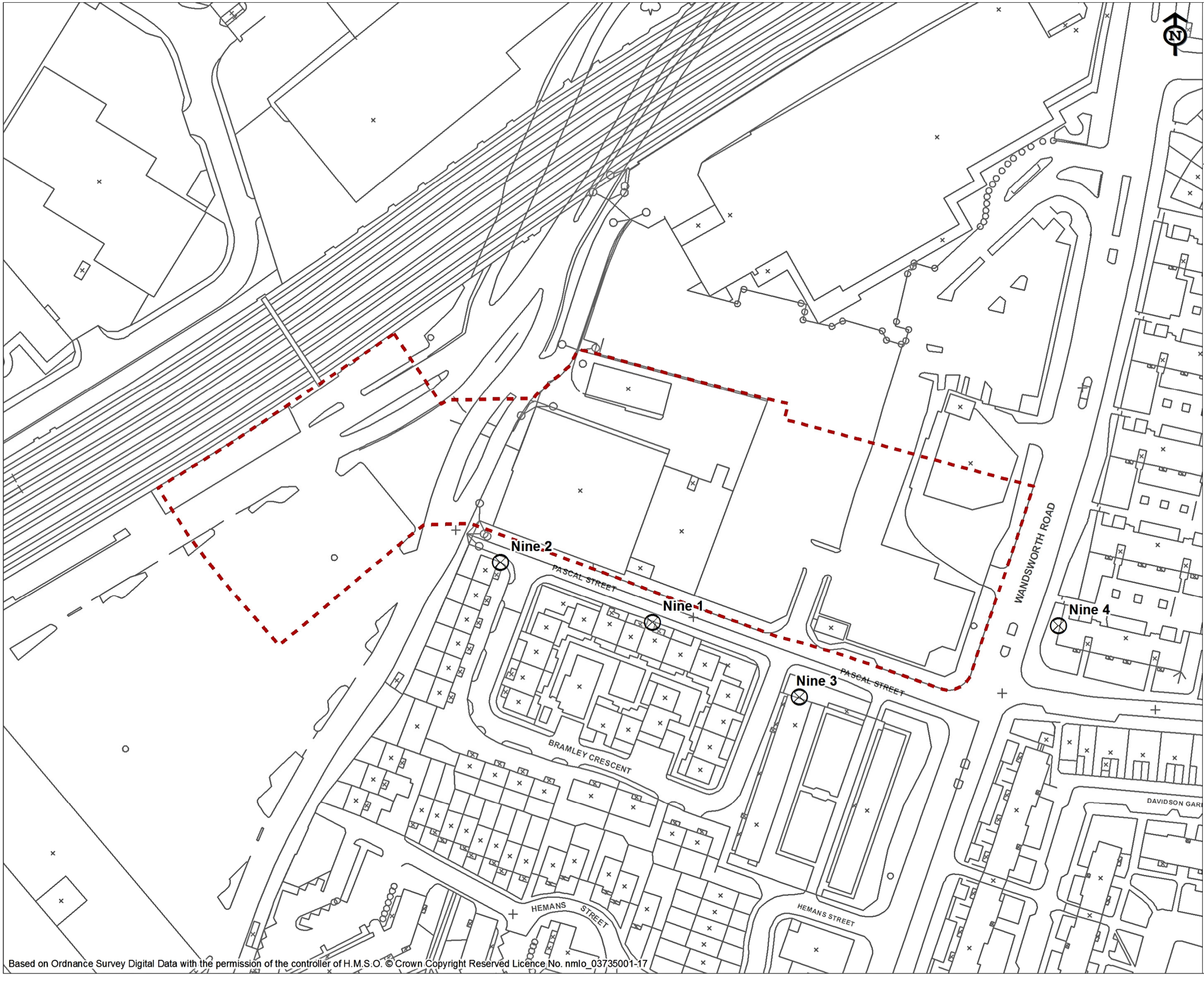
Approved by:	HW	Date:	04/03/2013

Drawing Scale: 1:2,000 @ A3

Drawing No: Figure 9-3

Revision: 01



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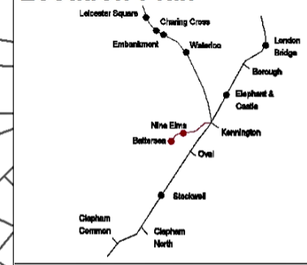

Key:

- ⊗ Noise Sensitive Receptors
- Indicative Construction Site

Client:

Transport for London

URS

Project:

NORTHERN LINE EXTENSION
TO BATTERSEA
TWAO FOR TfL

Drawing:

NINE ELMS STATION NOISE SENSITIVE RECEPTORS

Suitability: S4 FORMAL ISSUE TO CLIENT

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Approved by:	HW	Date:	04/03/2013

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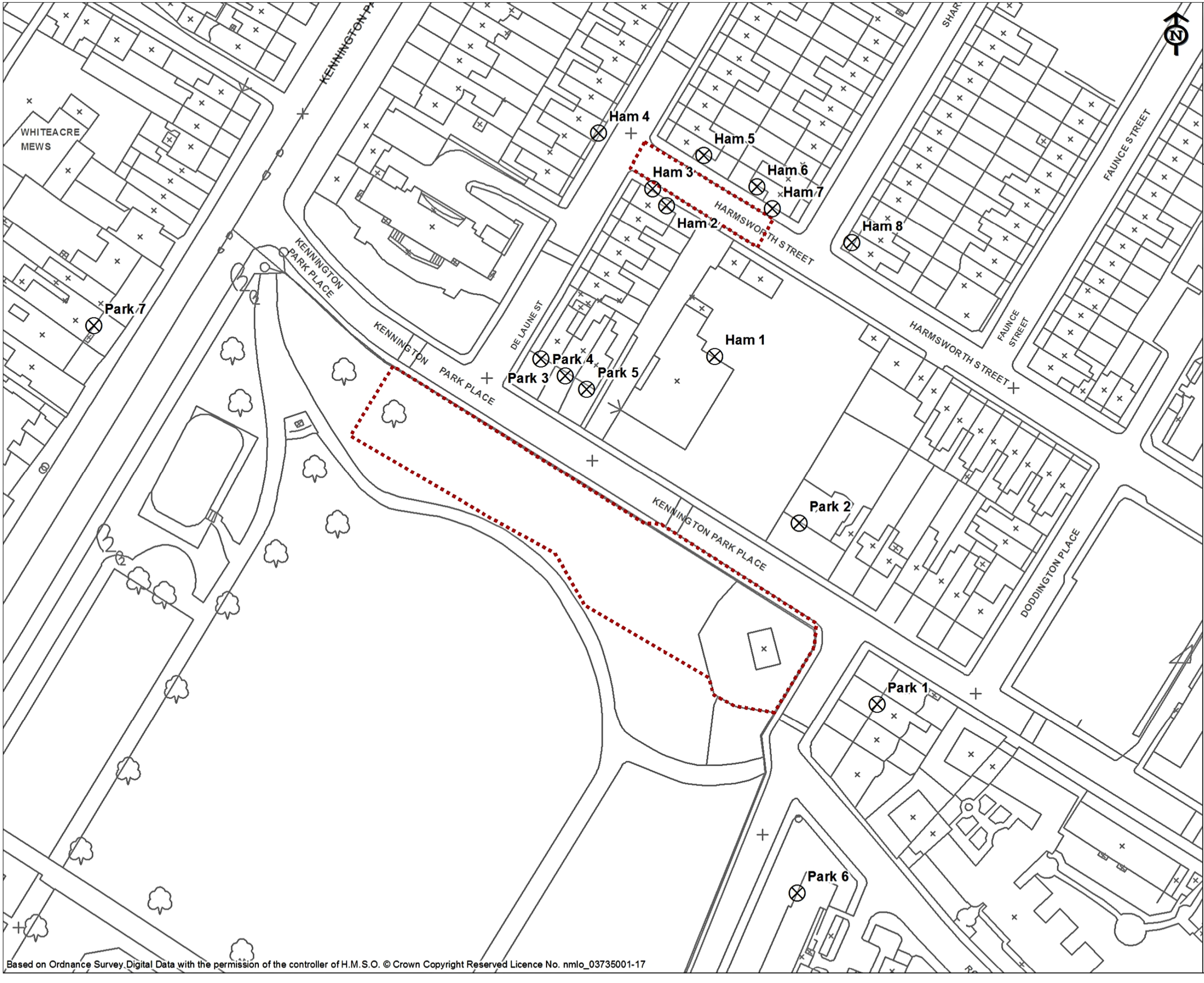
Drawing No: Figure 9-4

Revision: 01



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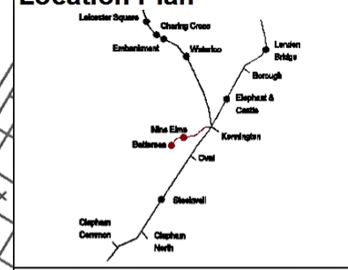

Key:

- Noise Sensitive Receptors
- Indicative Construction Site

Client: **Transport for London**

URS

Project: NORTHERN LINE EXTENSION TO BATTERSEA TWAO FOR TfL

Drawing: KENNINGTON PARK AND HARMSWORTH STREET NOISE SENSITIVE RECEPTORS

Suitability: S4 FORMAL ISSUE TO CLIENT

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Checked by:	TW	Date:	04/03/2013
Approved by:	HW	Date:	04/03/2013

Drawing Scale: 1:1,250 @ A3

Drawing No: Figure 9-5

Revision: 01

Green 1

Green 2

Green 3

Green 4

Green 5

MONTFORD PLACE

MONTFORD PLACE

PEGASUS PLACE

KENNINGTON ROAD

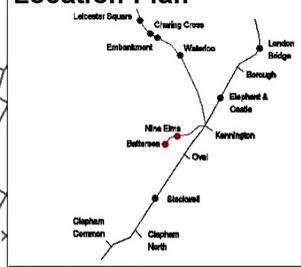
STANNARY STREET

Stannary Place

Aulton

N

Location Plan



Key:

- Noise Sensitive Receptors
- Indicative Construction Site

Client:

Transport for London

URS

Project:

NORTHERN LINE EXTENSION
TO BATTERSEA
TWAO FOR TfL

Drawing:

KENNINGTON GREEN NOISE SENSITIVE RECEPTORS

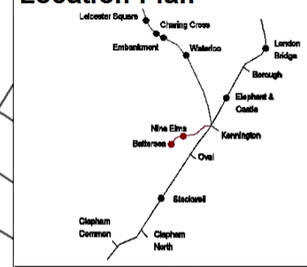
Suitability: S4	FORMAL ISSUE TO CLIENT		
Drawn by:	DT	Date:	04/03/2013
Checked by:	TW	Date:	04/03/2013
Approved by:	HW	Date:	04/03/2013
Drawing Scale:	1:1,000 @ A3		
Drawing No:	Figure 9-6	Revision:	01

RAVENSDON STREET

RADCOT STREET

Rad 1
Rad 2
Rad 3
Rad 4
Rad 5
Rad 6
Rad 7
Rad 8
Rad 9
Rad 10
Rad 11
Rad 12
Rad 13
Rad 14

Location Plan



Key:

- Noise Sensitive Receptors
- Indicative Construction Site

Client: **Transport for London**

URS

Project: NORTHERN LINE EXTENSION TO BATTERSEA TWAO FOR TfL

Drawing: RADCOT STREET NOISE SENSITIVE RECEPTORS

Suitability: S4 FORMAL ISSUE TO CLIENT

Drawn by:	DT	Date:	04/03/2013
Checked by:	TW	Date:	04/03/2013
Approved by:	HW	Date:	04/03/2013

Drawing Scale: 1:500 @ A3

Drawing No: Figure 9-7

Revision: 01