

1 Introduction

This document has been prepared by BuroHappold Engineering to support the planning application for the redevelopment of Northumberland Development Project generation area. The document outlines, based upon the present stage of investigations, the local utility networks and necessary on and off site utility construction works.

This Utility Strategy report reviews the existing facilities on site and identifies any relevant site constraints. The requirements for utilities have been determined from examination of the development proposals, as set out in the Development Specification. The demand for utilities has been estimated and initial discussions with the incumbent utility companies held.

The report identifies the anticipated need for on site improvements and off site reinforcements, based upon initial estimations. Further detailed work may be required as the development is realised.

The Strategy identifies certain design criteria and conceptual options for addressing the utility engineering requirements associated with the development.

The report provided details of the following areas:

- Water
- Power
- Gas
- Telecommunication
- Other Infrastructure.

In each section the key phases of works are identified.

2 Existing Site Constraints

2.1 Infrastructure Constraints

The Project Site application site is bounded by the following public highways:

- Tottenham High Road - runs north/ south and forms the western boundary
- Northumberland Park runs east/ west and forms the northern boundary
- Worcester Avenue runs north/ south and forms the eastern boundary
- Park Lane runs east/ west and forms the southern boundary

The High Road, and to some extent Northumberland Park, are major infrastructure routes, and will clearly impose significant restrictions on how and where new utilities enter the site

Surveys at key locations have confirmed that the eastern footpath of the High Road is extremely congested, which further limits where new infrastructure can be accommodated.

2.2 Existing Utility Network

The existing utility networks have been sized to serve the existing local area and also provide interconnectivity to the network as a whole. The utility loads of the site's former and present uses impose much lower demands than those required for the proposed development as the proposed built areas are greater and to a higher specification. Whilst there has been a significant amount of capacity released back into the network as existing buildings have been demolished and further will be released when the existing stadium is demolished, off site re-enforcement will be required. In particular :

1. the electrical supplier (UK Power Networks (UKPN)) indicate that the existing 33kV and 11kV power networks will require significant reinforcement, offsite, to the west and south.
2. discussions with Thames Water Utilities (TWUL) indicates that the potable water infrastructure will require minor reinforcement works.
3. The new development places a much higher level of demand on data networks, plus there is a requirement to improve resilience, hence new links to the main exchanges are to be provided.

A series of off-site reinforcement and supply measures have been discussed with the utility companies and principles have been established to provide appropriate levels of utility supply and resilience to the proposed development.

2.3 Strategic Utility Infrastructure

Based on information received there is no nationally significant strategic infrastructure effected by the proposals.

2.4 Water

Thames Water Utilities Ltd (TWUL) is the incumbent water company that supplies potable water to the new development area.

There is a trunk main in the High Road and there are a number of distribution mains running around the perimeter of the site, with six potable water supply mains of varying sizes currently supplying the development area.

2.5 Power

UK Power Networks (UKPN) is the incumbent network operator (DNO) that owns and operates the high voltage (HV) and low voltage (LV) electrical infrastructure within the region. The new development area is part of UKPN's eastern network.

There are various 11kV cable routes running around the perimeter of the site. Four existing substations / ring main units have been removed from the site and replaced with two within the North building (Lilywhite House) and one in the south west corner of the existing stadium (for the existing stadium only). At the time of writing, all electrical services in the centre of the development areas have been removed or disconnected to enable the construction of the new stadium.

All these substations are fed from UKPN's Bruce Grove 33/11kV primary substation, located approximately 1km to the south-west of the site.

2.6 Gas

National Grid Gas (NGG) is the incumbent network operator for high, intermediate, medium and low pressure gas infrastructure within the region.

NGG record drawings indicate that there is a medium pressure (MP) gas main that runs from White Hart Lane, north along High Road and then into Northumberland Park. This was recently renewed under a separate contract by the North London Gas Alliance.

There are numerous low pressure mains around the perimeter of the development with 12no services entering into the development.

2.7 Telecommunications

British Telecom (BT), Vodafone (ex-Cable and Wireless and Mercury) and Virgin Media (VM) all have infrastructure around the development area. BT has significant telecoms infrastructure in High Road, Northumberland Park and Park Lane. This infrastructure occurs on both sides of the carriageway, in order to maintain separate diverse routes and to serve properties on each side.

BT had several connections entering the development site. New BT provision has been made to the Lilywhite House development. The existing BT connections within the Wingate trading estate have all been disconnected as the buildings have been demolished. The BT infrastructure serving the remaining business on Paxton Road is to be removed in the Autumn of 2015. There remain BT cables serving the existing stadium, but these do not form part of strategic network routes serving other areas.

In total 9 no BT telecoms points entering into the development area have been identified from the record drawings. All of these points serve customers within the development area, and do not form part of a strategic network that serves other areas.

Vodafone has a strategic east-west link running in the High Road and Northumberland Park. The Vodafone (Cable and Wireless) route in Paxton Road has been diverted and the equipment in Paxton Road is redundant.

In a similar manner to BT, Virgin had several connections entering the development site. New Virgin provision has been made to the Lilywhite House development. The existing Virgin connections within the Wingate trading estate have been disconnected as have the cables serving on Paxton Road. These do not form part of strategic network routes serving other areas.

In a similar manner to BT, Virgin Media has significant infrastructure around the perimeter of the development, with 7no routes entering the development area. All of these points serve customers within the development area, and do not form part of a strategic network that serves other areas.

2.8 General

Detailed record drawing information has been received from the incumbent utility providers for their respective networks and this has been plotted onto a combined existing utilities drawing.

Each of the utility companies has been consulted to understand the "high level" impact of the new development on their networks and key assets, and have been asked to produce network studies for reinforcement.

Furthermore, detailed discussions are being held with the utility companies to understand the level of diversion work required and which mains need to be replaced and under what timescales. The extent of these more detailed discussions is outlined in the subsequent sections of this report.

Note that diversions have already commenced and been completed as part of an enabling works package to assist with the early stages of the construction program.

3 Phasing

3.1 General

The Project progresses in a number of stages and the utility infrastructure changes and upgrades need to follow and in some cases pre-empt each stage.

Diversions and new supplies for Lilywhite Home and Sainsbury's supermarket are now complete.

Key steps, to enable the new stadium construction, have been ;

1. Removal of utilities between Lilywhite House and the existing stadium,
2. Diversion of the electrical supply position to the existing stadium, now located off Park Lane.
3. Closure of Paxton Road, transfer to the ownership of THFC and removal of services.

The utility supplies to the existing stadium will remain in place as the new utilities to the new stadium are installed.

Once the existing stadium is closed, the existing utilities are then removed or made safe, and the existing stadium demolished, provisionally commencing June 2017.

Only following the demolition of the existing stadium can the new stadium can be completed and brought into use and the southern development commenced.

The Southern Development is likely to be constructed in two or more phases, with separate infrastructure to each phase.

Presently, the hotel, THFC Experience and Extreme Sports Building are planned to precede construction of the four residential towers and associated commercial space.

4 Water Supply

4.1 Existing Network

Thames Water Utilities Ltd (TWUL) is the incumbent water company that supplies potable water to the region, including the new development area.

There is a 400mm (16") diameter trunk main and 150mm (6") secondary distribution main that run north/ south under the High Road footway along the western boundary of the site. The trunk main supplies a wider area of north London, and also feeds the secondary distribution main network local to the site. The secondary distribution main is part of Thames Water's District Metered Area (DMA) 83. There is a 150mm branch that comes from the secondary main that runs east along Northumberland Park. Park Lane is served from a separate District Metered Area (DMA 80). Although connected to DMA 83, a valved connection keeps these networks hydraulically separate.

There are seven main potable water connections into the existing White Hart Lane Stadium. These are as detailed below:-

- Meter reference 98A 800 426 into North Stand from Paxton Road.
- Meter reference 04A 051 008 into North Stand from Paxton Road.
- Meter reference 02W 017 957 into East Stand from Worcester Avenue.
- Meter reference 95W 002 528 into South Stand from Park Lane.
- Meter reference 95W 008 087 into South Stand and West from Park Lane.
- Meter reference 97M974 102 into Club Shop.
- Meter reference 00M 256 703 into Bill Nicholson Way believed to serve Valentino's.

New water connections from Northumberland Park have been provided for the Lilywhite House development. This is supported by completed off-site strengthening works carried out by TWUL.

4.2 Design Constraints

All of these connections will be removed once the existing stadium is demolished.

At the outset of the project, Thames Water was provided with an anticipated peak demand for the development. This peak demand did not assume there would be any water demand reduction options (such as waterless urinals etc) incorporated into the design. Discussions with Thames Water have been continuing through the development of the design to ensure that the water needs of the stadium and other related developments can be met.

Thames Water has noted that there will be some off-site reinforcement works required in order for the new load not to adversely affect the supplies to existing developments.

4.3 Demand Assessment

The benchmarks used to estimate the peak loads are presented in the following table:

Table 4—1 Water benchmark sources and peak demands

Area	Water Benchmark	Peak Water Demand (l/s)
Stadium	Data used from existing stadium site and Benchmarked from Emirates	10.0

4.4 Water Supply Strategy

An application has been made for a new supply to serve the Stadium which also serves the Tottenham Experience but no application has yet been made for the Hotel or the southern residential. It is proposed to provide a new 125mm dia MDPE connection from the existing 6" distribution main in the High Road to serve the stadium. This will feed the proposed 200m³ storage tanks in the new stadium. The incoming connection will also serve the 185m³ sprinkler tanks in the basement of the new stadium.

The new connection will be made from the distribution main in the High Road to serve the new stadium, and this new main will also follow the perimeter of the stadium to the south to serve a new fire hydrant position on the site. This connection will provide all of the water needs to the stadium. An existing valve on the trunk main will be opened by Thames Water to reinforce the supply to the secondary distribution main to allow the stadium supply to be services. The existing valve is close to the new connection to the distribution main. It is also proposed to re-use the existing 6" main in the High Road to serve a new hydrant position at the northern most point of the stadium.

4.5 Reinforcement Requirements

Based on the initial flow rates sent to TWUL for their analysis, it was determined that in order to support the development, reinforcement work would be required in the following locations:-

Stadium

- Opening a currently shut valve on the 200mm dia connection between existing 400mm (16") dia trunk main and existing 150mm (6" dia) inlet main to network main DMA80 in the High Road east footway.
- Formal application for the hotel will be made shortly

Extreme Sports, Residential, North East Building

- No formal application has yet been made for the buildings requiring Outline planning permission.

4.6 Phasing

It is intended that the connection for the stadium will be complete in 2015 and will be used for Construction site uses until it becomes the permanent supply for the stadium.

5 Power Supply

5.1 Existing Network

UK Power Networks (UKPN) Energy are the incumbent network operator (DNO) owns and operates the high voltage and low voltage electrical infrastructure within the region, including the new development area.

UKPN record drawings identified 5no 11kV/400V local substations within the development boundary. These are listed in Table 5—1 below and no longer form a constraint on the Stadium construction.

Table 5—1 Details of existing substations

Name	Rating	Notes
Bennetts Close	750kVA	Bennetts Close substation has been replaced with two new substations – one RMU and substation serving the new supermarket, one substation serving the remainder of the Lilywhite house development
Moselle	750kVA	Disconnected & removed
Edward Barber	315kVA	Disconnected & removed
Paxton Road	2.2MVA	Replaced with RMU in south west corner of existing stadium, off Park Lane, supplies existing stadium only. Paxton Road RMU removed. Stadium connection to be removed prior to provision of supply to Phase 3.
Ex Paxton Road	-	Disconnected and removed

5.2 Design Constraints

UKPN has advised in 2010 that there is a significant shortfall in the current capacity of the 11kV network serving the area, however there is a general upgrade of Bruce Grove running from 2015 to early 2017 to which no specific contribution has been requested. This general upgrade involves new cable routes from Northumberland Park to the east, via Park Lane to the existing Bruce Grove primary substation to the south west.

As a consequence the maximum demand of the Stadium, 6MVA, from the 11 kV infrastructure will not be available until an as yet unconfirmed date in early 2017.

The physical infrastructure will precede the availability of the full capacity program in 2016 determined by the Stadium construction program.

As an independent connection, sufficient capacity does exist for construction purposes, notionally 1 MVA, from the existing local 11kV network.

For the southern development multi-use development (residential, hotel, sports) the release of the existing 2.2 MVA White Hart Lane stadium supply will help, however there is a possibility of further off site works being required when this application is submitted. The present scheme is estimated to have a demand of approximately 4 MVA.

Ancillary buildings, namely the THFC retail area and the North East building will also require power, which we anticipate as being available from the local Low Voltage UKPN network.

5.3 Demand Assessment

5.3.1 Stadium

The load assessment for the Stadium continues to be developed with the design of the Stadium, presently not exceeding 8 MVA under any match day scenario, and not exceeding 4 MVA on a non-match day.

The match day load can be split into six distinct parts of comparable sizes, some of which remain provisional.

1. Pitch lighting
2. Display screens
3. Cooling
4. Catering
5. Technology (IT, Security, Wi-Fi, 4G Wireless, Media)
6. General lighting and power.

The total of the above is in the order of 12 MVA however peak loads for each element are of relatively short duration and do not occur concurrently, hence the 8 MVA match-day maximum demand. This diversity factor has been informed by post-occupancy measurements at the Emirates stadium, equipment design plus load profiles from the THFC project team for IT and KCCJ (Catering loads).

This match day maximum demand is supported by the 6 MVA utility supply and on site power generation.

On non-match-days all loads are significantly reduced, and within the 6 MVA utility supply capacity.

In comparison with that drawn at the Emirates, a stadium of similar capacity, we expect the electrical load to be higher, due to the greater built area and higher level of service provision.

5.3.2 Southern Development – Residential

The southern development residential blocks and ancillary spaces have been assessed as having a maximum utility load of 3 MVA, which is based on units not having any electric heating and a minimal amount of mechanical cooling systems.

2 MVA of the total is for the true residential areas, 2 kVA per residence plus common areas. Each residence will have a dedicated utility meter.

The balance of 1 MVA is for the commercial, community and parking areas, the dominant element of this being an allowance of 100 W/m² for the commercial space.

A supply application has yet to be made to UKPN or 3rd party suppliers (IDNOs).

5.3.3 Southern Development – Hotel

The hotel is a single entity metered at one point, air conditioned throughout, with a maximum demand in the order of 600 kVA. An allowance of 100 KVA has been made for Catering.

The design is at an early stage so a supply application has yet to be made to UKPN or 3rd party suppliers (IDNOs).

5.3.4 Southern Development – THFC Retail

The THFC retail unit is a single entity metered at one point, air conditioned throughout, with a maximum demand in the order of 300 kVA.

The brief development is at an early stage so a supply application has yet to be made to UKPN or 3rd party suppliers (IDNOs).

5.3.5 North East Building

The NE building development is a single entity metered at one point, air conditioned throughout, with a maximum demand in the order of 300 kVA. This is based on a general commercial maximum demand of 200 kVA plus, following identification of specialist occupiers, an allowance for 100 kVA specialist equipment

The brief development is ongoing and a supply application has yet to be made to UKPN or 3rd party suppliers (IDNOs).

5.3.6 Summary

A simple summation of the loads above give a match day maximum demand of 10 MVA and non-match day demand of 8 MVA. However we anticipate these will both reduce by 2 MVA due to non-concurrent load profiles.

5.4 Power Supply Strategy

The dedicated stadium supply of 6 MVA will meet the non-match day load and match day match continuation loads as a minimum, with the on-site Generators meeting the maximum load of the Stadium in excess of the this figure. We are presently recommending a 6 MVA supply as no more costly than 4 MVA.

For details on the Power supply enquiries for the Stadium refer to the Stadium Electrical Design Note Rev 04, issued 17/12/2014.

Orders have been placed with UKPN for the stadium supply. UKPN will be resolving the implementation details, including 3rd party permits as part of their construction processes.. Refer to diagram overleaf for key issues.

No site wide CHP system is now proposed.

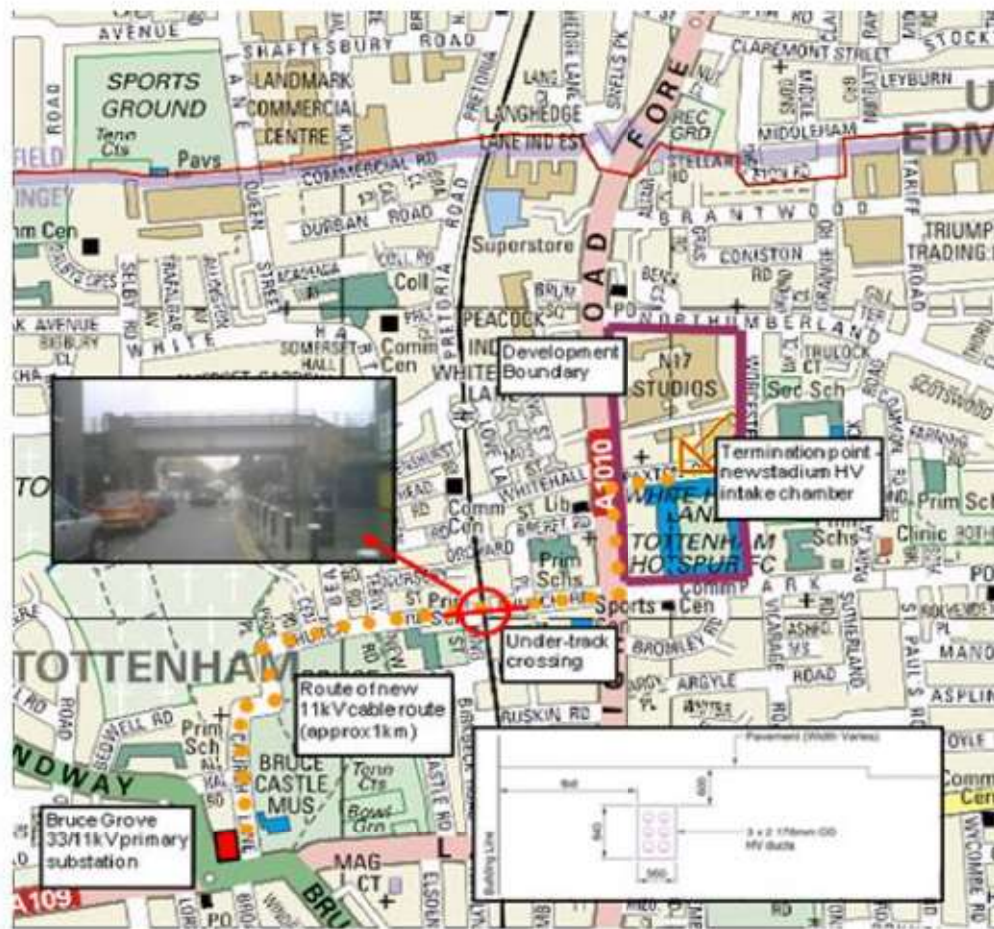


Figure 5—1 Potential route for 11kV works

5.5 Phasing

Due to the completion of the Enabling Works in 2014, phasing impacts for the Stadium are largely absent, other than the delay in availability of the full capacity.

The phasing due to the Residential / Hotel construction in parallel with the Stadium may cause complications but with no firm program for the this part of the development, planning has not being considered.

6 Gas Supply

6.1 Existing Network

Transco has recently revised its name and operations such that they are now known as National Grid Gas. Whilst National Grid Gas owns the gas assets, independent utility providers, for example, Fulcrum Connections and Exoteric Solutions, are often asked to execute modifications to, or to design sections of gas network. Each company has been consulted in relation to the new development.

National Grid Gas record drawings indicate that a medium pressure main runs along White Hart Lane, turning north into High Road, and then west into Northumberland Park. The main was subject to separate modernisation and upgrade works undertaken by the North London Gas Alliance (NLGA) in 2008.

The medium pressure main feeds various low pressure mains via a pressure reducing station in Trulock Road. These low pressure services then supply the surrounding areas, including the development.

The twelve main low pressure gas connections into the development are as detailed below:-

- 125mm PE gas main from High Road into Wingate Industrial Estate made redundant and removed
- 90mm PE main from High Road main made redundant and removed
- 90mm PE gas main from High Road into Paxton Road, now disconnected from the High Road. (note this was closed off by a Distribution Boundary Valve)
- 125mm PE gas main from High Road into Bill Nicholson Way
- 90mm PE gas main from Park Lane to property
- 90mm PE gas main from Park Lane to existing stadium
- 90mm PE gas main from Park Lane into Worcester Avenue, connecting to Paxton Road main. Strengthening works has been carried out in Worcester Avenue and Paxton Road link removed.
- 3 x 90mm PE and 1 x 63mm PE gas main from Northumberland Park into industrial estate made redundant and removed.
- 63mm PE gas main from Worcester Avenue into industrial estate made redundant and removed
- New gas supplies laid into Lilywhite house.

6.2 Design Constraints

National Grid Gas has been consulted and an approved gas safe installer appointed to undertake the following works:

- A new Low Pressure gas supply made into the main in the High road, across the High Road and terminated within the Site Boundary adjacent to the Lilywhite house entrance ramp.
- A second visit will be made once the stadium meter room is built to install the meter and MP gas booster set.
- Risk assessments carried out by National Grid Gas

- Security, access maintenance etc.

The strategy will be developed as part of the detailed design process.

6.3 Design Assessment

The gas demand will need to supply the heating and hot water demands of each individual buildings in the development as well as any catering requiring gas supply. The benchmarks used to estimate the demands are presented in the next table.

Table 6—1 Gas benchmark sources and peak demands

Area	Gas Benchmark	Peak Gas Demand
Stadium	Data used from other BH projects, notably Emirates Stadium	10.00MW
Tottenham Experience	Data used from other BH projects	Included in Stadium demand
Extreme Sports	Based on preliminary calculations	150kW
Residential	Based on preliminary calculations	3360kW
Hotel	Based on preliminary calculations	2000kW
NE Building	No Gas Required.	N/A

6.4 Gas Supply Strategy

For the stadium and remainder of the site, it is envisaged that a single connection to the Low pressure main in High Road will be made opposite the Lilywhite House access ramp with the connection crossing the High Road to enter the stadium site in the north west corner. National Grid Gas has confirmed that the low pressure main is capable of supplying the required load to the development.

The low pressure service to the stadium will terminate with an emergency control valve (ECV) within purpose built enclosure, as required by regulations. From this point, the service to the stadium will be picked up by the stadium design team.

It is anticipated that there will also be a connection to the low pressure cast iron main in Park Lane to serve the southern half of the development. It is the intention at this point to re-use an existing 90mm PE connection. The proposed energy strategy makes it likely that there will be no requirement for gas to the residential areas, for cooking. Heating and hot water will be catered for by connection to the central heating system. Cooking will be electric.

6.4.1 Phasing

New supplies have been provided and are in use serving Lilywhite house and the supermarket. Strengthening works have been completed in Worcester Avenue to allow removal of the Paxton Road gas main once it is no longer needed.

The new stadium supply is being laid into the edge of the site in the summer of 2015 as enabling works and is to be continued into the stadium gas enclosure as part of the main stadium construction.

Once the stadium gas supply has been completed, no further gas supply will be needed within the development until the hotel is constructed, where the existing gas main previously capped off can be re-used.

7 Telecommunications

7.1 Existing Networks

Services from all three major telecoms and broadband providers exist in the highways around the development site as described below.

BT record drawings indicate that there is extensive existing infrastructure on all sides of the development. This includes multiple duct services on both sides of the surrounding carriageways, however, it should be noted that there is duct congestion and duct damage in some of the routes. Main BT infrastructure enters the development in nine locations. There are no primary cross connections through the development, meaning the infrastructure entering the development zone only serves facilities within it. There are no major diversions required of the BT infrastructure in the development site. The services in Paxton Road and in the demolished Wingate Industrial estate have been back to the main infrastructure in the High Road as part of the enabling works.

In addition, public telephone call boxes exist on the north side of Northumberland Park, on the High Road south of Park Lane, south of White Hart Lane and north of Northumberland Park. A further telephone call box is currently located at the front of the existing Tottenham megastore on the High Road; this is to be removed by BT as part of the enabling works packages for the stadium development. Public Telephone

Virgin Media record information indicates that there is also extensive infrastructure around the development in the High Road, Northumberland Park and Worcester Avenue. There are no primary cross connections through the development, meaning the infrastructure entering the development zone only serves facilities within it. There are no major diversions required of the Virgin Media infrastructure in the development site. The services in Paxton Road and in the demolished Wingate Industrial estate have been removed back to the main infrastructure in the High Road as part of the enabling works.

Vodafone (Cable and Wireless) record drawings indicate that there are two primary routes that run east-west across the area, with one running through the development zone, via Paxton Road. This route via Paxton Road has been diverted as part of the enabling works process via High Road and Northumberland Park, and the equipment in Paxton Road is redundant. Vodafone have infrastructure in Worcester Avenue serving the stadiums outside broadcast area to the east of Worcester Avenue.

7.2 Design Constraints

It is not expected that an extensive telecoms infrastructure will be required to run across the site, as the existing infrastructure on each of the boundary edges will provide the necessary services.

The telecoms and broadband suppliers have confirmed that they can provide service to the site, either from their existing networks local to the site or by strengthening their system with additional lines and fibre connections from elsewhere.

Telecoms and broadband connections will be required to all buildings proposed on the site including the residential, hotel, extreme sports and north east building in addition to the stadium.

7.3 Design Objectives

To address future technology and business trends there are a number of key criteria that will be considered for the communications infrastructure including:

- No single point of failure, resilience and adaptability;
- Infrastructure for multiple telecoms and broadband operators;
- Infrastructure for tenants and new development operator/ maintainer;
- Minimised civil engineering works;
- Co-ordination with other utilities;
- Installation phased with the development.

Careful consideration will be given for different zones i.e. the telecoms infrastructure required for a large commercial and business zone will be much larger and require more security than a predominantly residential zone.

7.4 Telecoms Supply Strategy

Direct connection to the existing telecoms and broadband infrastructure will be made. The stadium is to have provisions from at least two separate points/providers to maintain a diverse and resilient infrastructure..

It is intended to bring in new services to each of the buildings' telecoms equipment rooms from the following locations.

Table 7—1 Telecoms indicative provision and connection points

Area	Likely Connection points	Potential Providers	Indicative Infrastructure
Stadium intake 1	High Road - East side	BT, Vodafone, Virgin Media	300 lines and fibre connections
Stadium intake 2	Worcester Avenue – West side	BT, Vodafone, Virgin Media	300 lines and fibre connections
Outside Broadcast Compound	Worcester Avenue – East side	BT, Vodafone, Virgin Media	100 lines and fibre connections (Installed and complete)
Supermarket	Northumberland Park	BT, Vodafone, Virgin Media	100 lines and fibre connections (Installed and complete)
Hotel	Park Lane – North side	BT, Vodafone, Virgin Media	100 lines and fibre connections
Tottenham Experience and Retail	Served from Stadium		
Residential and Commercial Space	Park Lane – North side	BT, Vodafone, Virgin Media	1 line per residential unit, plus 50 lines per residential block and fibre connections, 100 line for Commercial space plus fibre connections
Extreme sports	Park Lane – North side	BT, Vodafone, Virgin Media	100 lines and fibre connections
Northern Terrace	High Road – East side or Northumberland Park – South side	BT, Vodafone, Virgin Media	100 lines and fibre connections
North East Building	Worcester Avenue – West side	BT, Vodafone, Virgin Media	100 lines and fibre connections

It is anticipated that the strategy for the telecommunications network will be a series of multi way ducts and chambers that will be a mixture of BT, other telecoms providers, and estate (BMS, security etc). The duct strategy will be developed further with interested parties as the development progresses, but will follow the main utilities corridor layouts around the perimeter of the stadium.

7.5 Phasing

Elements of telecoms infrastructure require relocation for the development project and this work is being carried out as enabling works in advance of the main development phase. The enabling works are nearing completion in terms of telecoms alterations. As part of the enabling works, the Vodafone (Cable and Wireless) route through Paxton Road has been diverted, Virgin and BT lines in Paxton Road have been removed, BT above ground cabinets on the High Road have been relocated and new telecom and broadband lines provided to the outside broadcast area, supermarket and Lilywhite house. Two BT cabinets and a telephone kiosk on the High Rd north of Park Lane are in the process of being moved.

The telecoms connection points in High Road and Worcester Avenue will be provided to serve the first stages of development with lines and fibre connections together with their associated telecoms infrastructure

Further lines and fibre connections will be provided for the hotel, extreme sports and residential units served from High Road and Park Lane.

8 Other 3rd Party Infrastructure

8.1 Transport for London Signals, Street Lighting and Signage

There are proposed modifications to the existing signals at the Park Lane / High Road junction, and to the pedestrian crossings on the High Road adjacent to the stadium as part of the highways works package associated with the stadium.

There will also be modifications required to the street lighting, CCTV, road and pedestrian signage on the streets surrounding the development.

These works will be designed and procured by Haringey Council Highways as part of their highway works packages, and do not form part of the works described in this report.

Worcester Avenue may also be partly taken out of public ownership with lighting and other services run from the Stadium. The extent of this is under discussion between THFC and Haringey Borough Council.

9 Conclusions

The new development can be served with all utilities but there will be off site strengthening required to some utilities.

The required HV electric supply requires strengthening of the strategic UKPN networks at Bruce Grove; this is already in hand as an independent UKPN project due for completion in early 2017. A new 11kV cable route is to be laid from Bruce Grove substation to the site area to provide supply. The order for this work has been placed with UKPN.

Additional connections will be made to the local LV and HV networks to supply the other parts of the development in phases to suit construction. A contractors site supply will also be provided.

The gas supply for the stadium is to be taken from the existing low pressure main in the High Road and National Grid Gas have confirmed there is sufficient capacity with no strengthening. The stadium supply is in the process of being laid as enabling works. Connections will be laid for the other parts of the development and be served from the local distribution networks.

The potable water supply for the stadium is to be provided from the existing distribution network in the High Road. Strengthening is required but this consists of opening an existing valve to allow a greater flow from the existing trunk main to the local distribution network. The stadium supply is to be laid and used and a construction site supply until required for the stadium. Connections will be laid for the others parts of the development and be served from the local distribution network.

The telecoms and broadband services to the stadium and the other parts of the development will be provided from the existing infrastructure in the streets around the stadium. Strengthening may be required depending on which providers are use but this will be arrange and carried out by the provider.

The utilities will be provided in stages for the new development to suit the phasing of construction.

Existing utilities serving the existing stadium will be kept in place until the stadium goes out of use and removed at that stage.

An enabling works package has carried out a significant proportion of the utilities removals including removal of HV substations from the areas demolished in advance of the stadium project. The enabling works package also included utilities diversions to assist the construction process. In particular, utilities services have been diverted or removed from Paxton Road, the HV ring main in the stadium has been moved away from the north east corner, BT infrastructure on the High Road has been relocated and replacement outside broadcast infrastructure has been provided. The majority of the enabling works is now complete.

Appendix A Combined Utilities Drawing



Figure 9—1 Existing combined utilities drawing

Appendix B Development image Plan



Figure 9—2 Development image

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Executive Summary

This report has been produced to consider crowd safety issues, and the feasibility and implications of retaining the following three locally listed buildings on High Road:

- No. 746 High Road (known as the Edmonton Dispensary)
- No. 748 High Road (known as the Redhouse Coffee Palace)
- No. 750 High Road (formerly Valentino's Nightclub)

All three of these buildings were retained in the previously approved scheme (HGY/2010/1000) ("the Consented Scheme"). However, as detailed in the Planning Statement prepared by DP9, circumstances have changed since the previous proposals were approved in 2011.

Movement Strategies (MS) on behalf of THFC has undertaken a detailed assessment of current conditions at the existing stadium. This assessment has identified large numbers of spectators walking in the High Road before a match as a consequence of the 'pinch point' created by the narrow footpath in front of nos. 746/748 and 750 High Road.

The Consented Scheme provides a "canyon" behind the three buildings, which was designed to divert spectators away from this recognised pinch point. MS has concluded that the canyon would not be effective in diverting spectators from the natural route along the High Road.

As such, the retention of the four buildings in the Consented Scheme will deliver a clear risk to pedestrian safety.

Having identified this risk, THFC and its design team are committed to securing a design to reduce the degree of risk to spectators and the general public to as low as reasonably practicable ("ALARP"), which presumes that change is made in favour of safety unless the cost is grossly disproportionate to the benefit.

MS has undertaken a detailed assessment to determine acceptable levels of service in this situation, as a basis for evaluating a series of alternative options to seek to reduce the risk to ALARP.

The proposed new scheme designed by Populous, which involves the removal of the three locally listed building, has been tested using the same methodology.

This option has been found to be acceptable in crowd safety and highways and transport terms. This option reduces the risk to spectators and the public to ALARP.

A number of options have been considered, ranging from the introduction of intensive stewarding and barriers, to the temporary and permanent closure of the bus lane and both south bound lanes, to more radical options including moving the High Road, providing a flyover or tunnel, or constructing an elevated walkway in front of the NDHA. MS conclude that the retention of the three buildings, delivery of the 'canyon' and the provision of intensive stewarding and barriers on the Eastern and Western sides of the High Road would not provide a satisfactory solution to the identified safety concerns.

The MS analysis excludes the additional impacts arising from reoccupation of the buildings by food and beverage ("F&B") operators, which are the only viable source of commercial occupier demand for the three buildings. However this demand is conditional on the provision of external space for smoking/drinking on match days. This external space would need to be limited and contained spatially, and access and queuing managed to minimise congestion in the canyon.

Based on the views of Davis Coffey Lyons, it is uncertain whether the imposition of such management restrictions would be compatible with operators' requirements for these units. In these circumstances the viability of these units for F&B uses is uncertain given the constraints imposed by safety considerations.

The series of options involving the temporary/permanent closure of the southbound bus lane, or the closure of both southbound lanes all cause significant highways and transport issues, including congestion, unacceptable route diversions, and loss of public transport accessibility, which are inconsistent with the transport strategy and wider accessibility objectives. In any event, none provides a satisfactory, permanent solution to the identified safety concerns.

The more radical options have been discounted on the basis that they are not deliverable, (without fundamentally undermining the viability of the project and imposing unacceptable delays to delivery), and that any possible benefits in terms of the retention of the three buildings would be outweighed by very significant highways, traffic and heritage impacts elsewhere. These options would be likely to lead to significantly more harm to heritage assets than the proposed scheme.

In these circumstances, the revised proposals, involving the removal of the three buildings (but the retention of the statutorily listed Warrington House), provide the only deliverable solution which is acceptable in highways and transport terms and reduces the identified risk to spectators and the public ALARP. This is a very important material consideration, which must be weighed in the overall planning and heritage balance, which is set out in the Planning Statement.

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1.0 Introduction

1.1 This report has been produced to consider crowd safety issues, and the feasibility and implications of retaining the following three locally listed buildings on High Road:

- No. 746 High Road (known as the Edmonton Dispensary)
- No. 748 High Road (known as the Redhouse Coffee Palace)
- No. 750 High Road (formerly Valentino's Nightclub)

1.2 All three of these buildings were retained in the previously approved scheme (HGV/2010/1000) ("the Consented Scheme"). However, as detailed in the Planning Statement prepared by DP9, circumstances have changed since the previous proposals were approved in 2011.

1.3 As part of a detailed review of the Consented Scheme THFC commissioned Movement Strategies ("MS") to undertake a review of the crowd safety matters.

1.4 Although Nos. 744 - 750 High Road have traditionally been treated as group for the purposes of preparing and evaluating previous planning applications for the replacement stadium scheme, there are important distinguishing characteristics that separate No. 744 High Road from Nos. 746 - 750 High Road.

1.5 No. 744 High Road is set back from the back of pavement by 14.5m, providing an effective footpath width of 10.2m¹ for crowd flow.

1.6 In contrast No. 746 is set back by 4.2m; No. 748 by 2.2m; and No. 750 High Road by 2.6m.

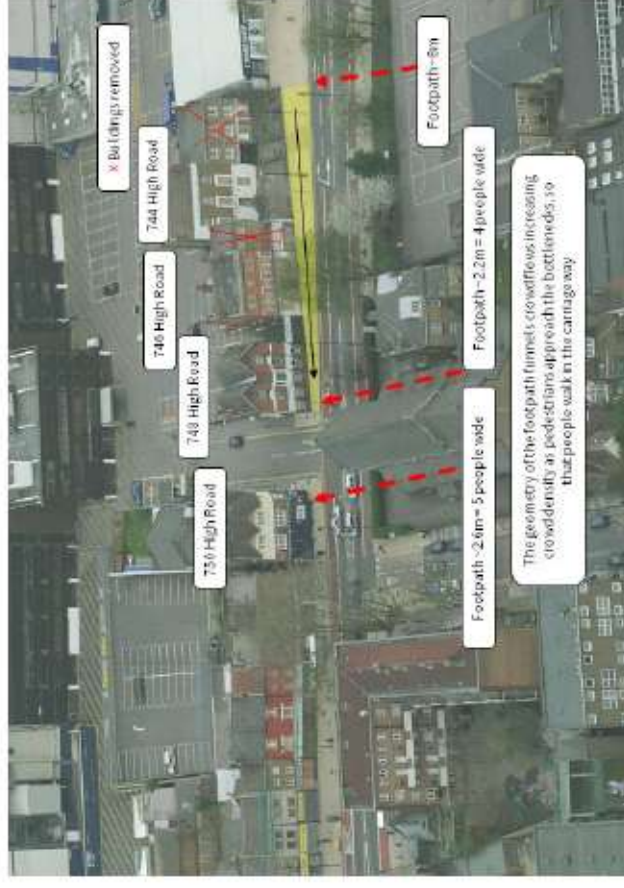


Figure 1 Aerial view of 744 – 750 High Road

1.7 Whereas the footpath width formed by No. 744 High Road is sufficient to allow safe crowd movement, the narrow and narrowing pavement width caused (Fig. 1) by the much smaller set-backs in front of Nos. 746 - 750 High Road causes significant numbers of pedestrians to walk in the road before a match. Evidence for this is shown from the numerous crowd flow surveys undertaken during the 2014/15 season.

1.8 The significant numbers of pedestrians in the road presents risks to pedestrian and driver safety.

1.9 The A1010 High Road is a Strategic Road within the TfL road hierarchy – only one level below the Priority (Red) Routes such as the A10 south of Bruce Grove. The Northumberland Development Project is unusual in that it proposes a large stadium immediately adjacent to such a major road.

1.10 LB Haringey is the highway authority but TfL have an effective control over any works and traffic management within the public highway. Both authorities have a responsibility to safely manage the adopted highways. There are significant additional safety considerations associated with the operation of a stadium, and the licensing regime, which also have to be taken into consideration. Crowd safety is a key issue.

1.11 The relationship between the stadium and the use of the High Road gives rise to a number of important crowd safety and transport issues. Figure 2 shows stills from video surveys during the 2014/5 season, which illustrate the typical pre match situation at the pinch point. The pedestrian and vehicular conflicts, and resultant safety issues are self evident.

¹ Width reductions applied for the proposed new bus stop (2m) accepting that the bus stop furniture could be less obtrusive with appropriate design but would still attract waiting passengers, the stairs for Warrington House (1.9m), and a 0.2m edge effect on the bus stop and building edge in line with TfL Pedestrian Comfort Guidance.



Figure 2 Stills from video surveys during the 2014/15 season

1.12 This report:

- Explains why crowd safety issues arise;
- Sets out an analysis of current crowd flows;
- Explains the approach taken to minimise crowd safety risks;
- Identifies suggested targets to minimise risks to acceptable levels;
- Sets out predicted crowd flows for the new stadium;
- Analyses the relationship between crowd flow issues and the future use of the three locally listed buildings; and
- Explains the relationship between crowd flow issues and the wider transport strategy for the new stadium.

1.13 Against the background of this information the report analyses a number of design and management options retaining the three buildings and evaluates those options in terms of:

- Whether they will adequately resolve the crowd safety issues;
- Their implications for the local and strategic transport network;
- Their impact on the viability of the ongoing use of the three buildings; and
- Their deliverability.

1.14 This report has been jointly produced by Movement Strategies (crowd movement consultants); Populous (joint architects for the proposed stadium and Tottenham Experience); and Tim Spencer & Co. (transport consultants). The report should be read in conjunction with the Heritage Impact Assessment chapter of the Environmental Statement (and the separate Heritage Statement), which have been prepared by Donald Insall Associates, and the report by Davis Coffey Lyons which considers occupier demand for these units and potential occupiers operational requirements.

1.15 The Planning Statement (prepared by DP9) draws together all the relevant considerations, including safety, deliverability, transport and highway issues, heritage, and the wider heritage, regeneration and other substantial public benefits which the scheme delivers, to assess the justification for the removal of the three buildings in the context of the relevant legal and planning tests.

2.0 Analysis of Crowd flow survey data

2.1 Count locations and time

2.1.1 Counts of people walking on the road and walkway were undertaken from video footage of ingress to a number of matches in the 2014/15 season. The results from the match vs. Hull City on 16th May 2015, 15:00 are described below. This match represents a typical Saturday afternoon fixture.

2.1.2 Each minute from 13:35 to 15:05 was counted separately. Three locations were counted on the eastern footpath of the High Road:

- Outside 748 High Road where the total width is 2.2m, and effective width 1.8m
- Outside 750 High Road where the total width is 2.6m, and effective width 2.2m
- Just north of Paxton Rd where the total width is 4.5m and effective width 4.1m

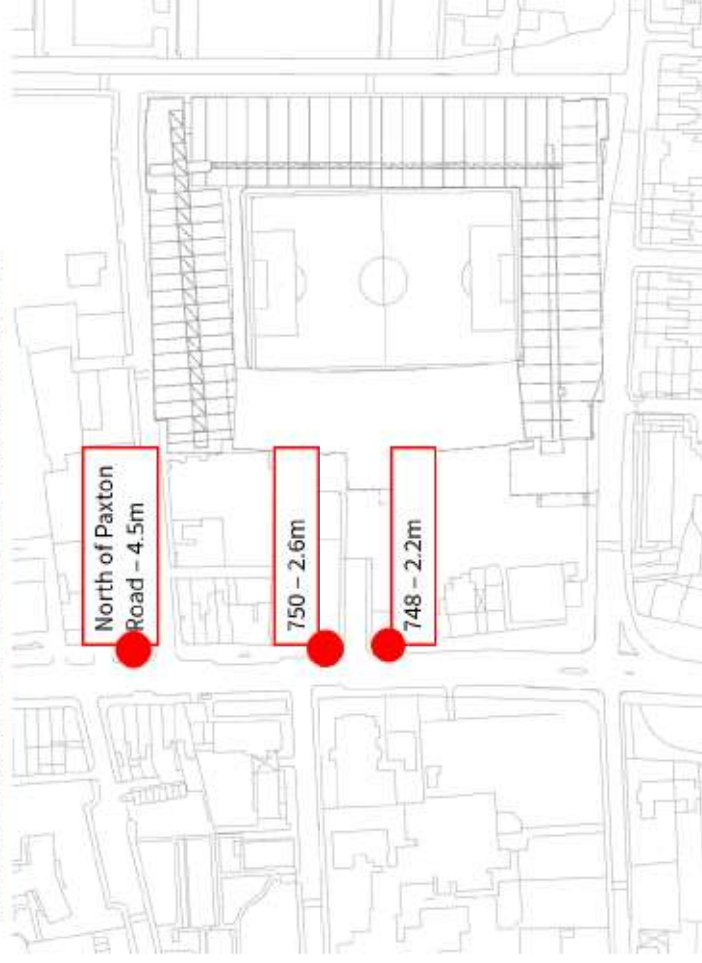


Figure 3 Locations where video surveys have been analysed and widths of walkways at these locations

2.2 Results

2.2.1 The number of people in the road is significant throughout the assessment period.

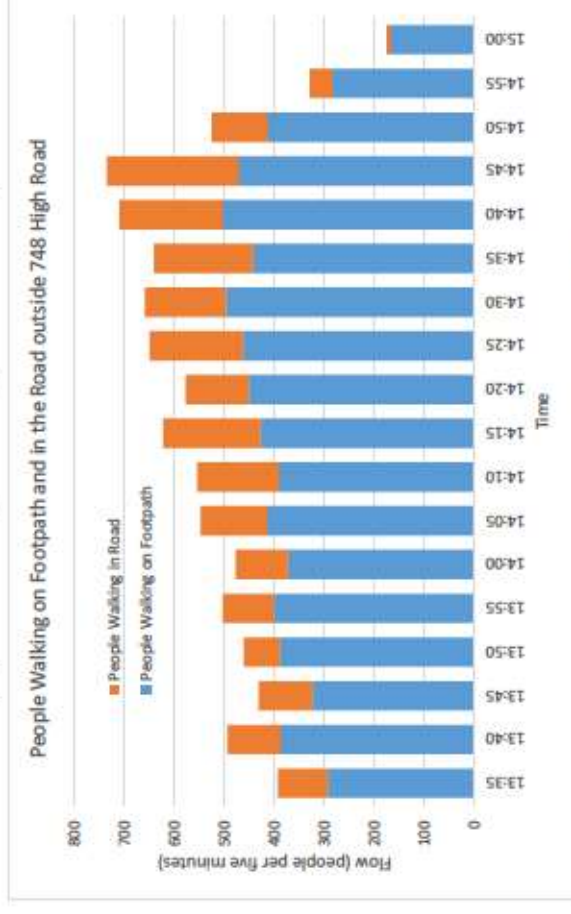


Figure 4 Flows each 5 minutes past 748 High Road during the match vs. Hull City 16th May 2015 15:00 kick-off

2.2.2 Throughout the assessment period, 2,388 (25% of) people walked in the road outside 748 High Road.

2.2.3 During the hour before the match this percentage was higher (27%), and higher again in the peak fifteen minute period (30 minutes to 15 minutes before kick-off) (32%) and peak five minutes (15 minutes before kick-off) (36%).

2.2.4 Survey data from other matches produced similar results. For example, in the hour before the West Ham match on 22 February 2015, 12:00pm kick off, 2,436 people walked in the road. That was 33% over the hour, and up to 40% during the peak periods.

2.3 Contraflow

2.3.1 Outside 748 and 750 High Road the flow was two-directional, with at most 61% observed in one direction during any five minute period. The direction which had the majority of flow was sometimes northbound and sometimes southbound. On average the flow in each direction was almost equal with 53% at 748 High Road and 56% at 750 High Road going northbound.

2.3.2 In contrast, north of Paxton Rd and thus north of the whole stadium, during the hour before kick-off, the flow was predominantly one directional southbound towards the stadium. There was only 3.5% contraflow over the hour and 1.5% during the peak fifteen minutes. Prior to that hour there was an average of 19% contraflow.

2.4 Analysis of Proportion in the road vs. flow rate

2.4.1 The total number of people in both on the walkway and on the road (people per minute) has been divided by the walkway width (metres) to produce a flow rate (people per metre per minute) for the three locations.

2.4.2 Outside 748 High Road

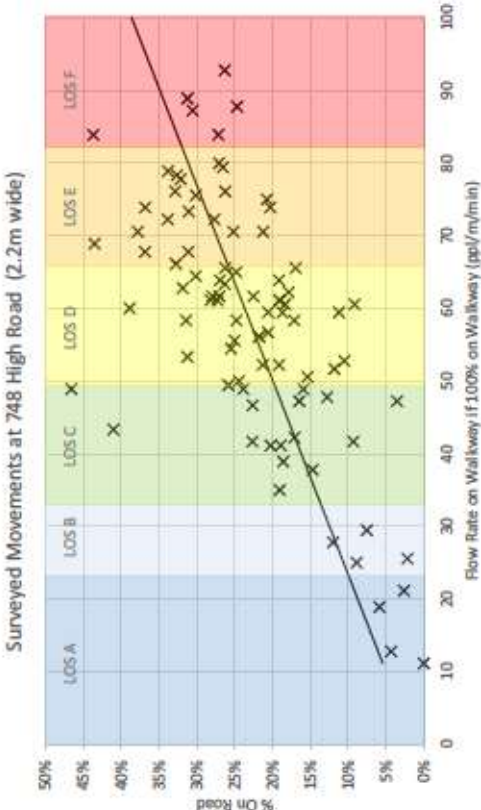


Figure 5 Percentage of pedestrians in road vs implied flow rate if all people on the footpath outside 748 High Road

2.4.3 There was only one minute at the end of the survey period (shortly after the match had kicked-off) during which no people were observed in the road. The survey identified that people walked in the road at low flow rates.

2.4.4 The graph demonstrates a positive relationship between the flow rate on the footpath and the number of people who will walk in the road. However, from the information collected, it is impossible to establish a flow rate below which no people will walk in the road.

2.4.5 Outside 750 High Road

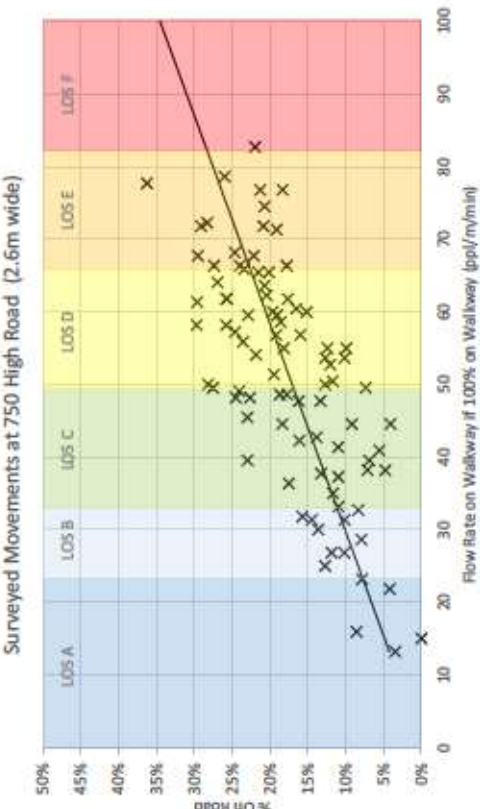


Figure 6 Percentage of pedestrians in road vs implied flow rate if all people on the footpath outside 750 High Road

2.4.6 There was only one minute, two minutes after kick off, during which no people were observed in the road.

2.4.7 Again the graph demonstrates a positive relationship between the flow rate on the footpath and the number of people who will walk in the road.

2.4.8 The percentage of people in the footpath (width 2.6m) is higher than outside 748 (width 2.2m) at the same flow rates.

2.4.9 North of Paxton Road

Surveyed Movements North of Paxton Road (4.5 m wide)

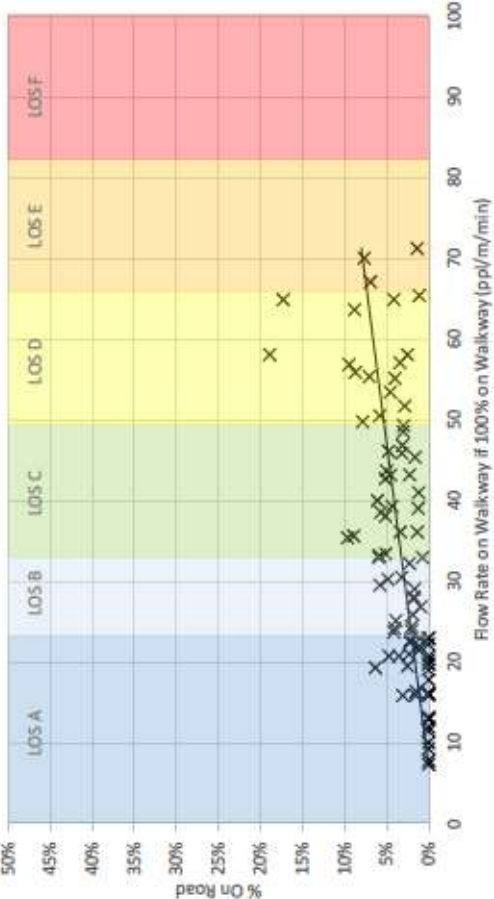


Figure 7 Percentage of pedestrians in road vs implied flow rate if all people on the footpath north of Paxton Road

- 2.4.10 Across the 90 minutes surveyed there were 23 minutes during which no people were observed walking in the road. Almost all of these observations were outside the peak hour before kick-off. During the period 14:00-14:57 there was only one minute (at 14:22) during which no people were observed walking in the road.
- 2.4.11 There is a positive relationship between the flow rate and the number of people walking on the road.
- 2.4.12 The percentage of people in the road was lower than at 748 and 750 at the same flow rates.

2.5 Comparison of all three locations

- 2.5.1 Results from the three sites have been plotted on the same chart, with linear trend lines fitted to each to aid in comparison.

Comparison of Percentages Using the Road in different parts of the High Road

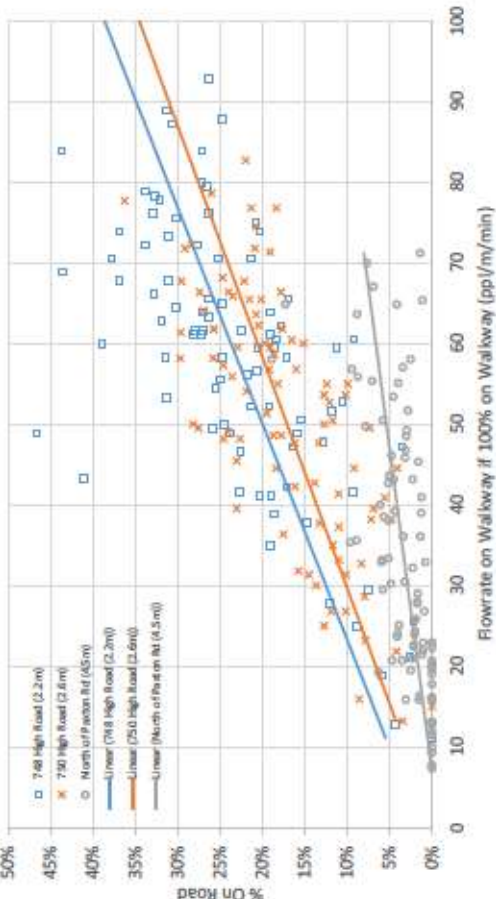


Figure 8 Comparison of flow rate on road and percentage in the road at the three locations.

- 2.5.2 As the width of the footpath increases, the percentage of people walking in the road decreases.
- 2.5.3 As the flow rate increases, the percentage of the people in the road increases.

2.6 Conclusions from the survey data

- 2.6.1 On the High Road approaching the stadium fans walked in the road even at low flow rates at all three sites.
- 2.6.2 The width of 4.5m north of Paxton Rd was not sufficient to encourage all of the fans to remain on the footpath.
- 2.6.3 Results from video surveys along the High Road demonstrate that:
- the proportion of people walking in the road increases as the flow rate increases;
 - the narrower the pavement width the higher proportion of pedestrians who will walk in the road; and
 - At narrow footpath widths pedestrians walk in the road even at low flow rates as there is little opportunity for them to manoeuvre past other pedestrians and remain on the walkway. This problem is exacerbated due to the number of spectators who arrive at the stadium in groups.

3.0 Crowd Flows

3.1 Safety Defining Appropriate Standards

3.1.1 The analysis of the current conditions experienced by spectators at the existing stadium identifies a significant risk to safety as a consequence of the number of spectators walking in the road in the period before matches.

3.1.2 The risk arises from the narrow, and narrowing, footpath along the High Road outside the buildings. There is insufficient space so that the pedestrians bypass slower moving pedestrians or avoid conflict - or anticipated conflict - with counter flows by stepping into the available space in the bus lane. The frequency of conflicts is increased in this situation by the presence of a high proportion of groups visiting the stadium, and the narrowing footpath that creates higher crowd densities.

3.1.3 Against this background THFC and its design team have sought to design the new stadium and its environs to reduce risks to spectators to be As Low as Reasonably Practicable ("ALARP").

3.1.4 *"Making sure a risk has been reduced ALARP is about weighing the risk against the sacrifice needed to further reduce it. The decision is weighted in favour of health and safety because the presumption is that the duty-holder should implement the risk reduction measure."*

3.1.5 *To avoid having to make this sacrifice, the duty-holder must be able to show that it would be grossly disproportionate to the benefits of risk reduction that would be achieved. Thus, the process is not one of balancing the costs and benefits of measures but, rather, of adopting measures except where they are ruled out because they involve grossly disproportionate sacrifices.²*

3.1.6 This report assesses the proposed scheme against this objective, and considers whether it is feasible to reduce risks to ALARP while retaining the three locally listed buildings.

3.1.7 The starting point of the analysis is to consider appropriate flow rates at which the risk is reduced to ALARP.

3.1.8 This requires consideration of the concept of the Level of Service that pedestrian visitors to the stadium will enjoy. Level of Service relates the circumstances and conditions experienced by pedestrians (including whether they are likely to experience conflict) to flow rates and crowd densities.

3.1.9 It is necessary to consider both the flow rates at which there are few pedestrian conflicts and also whether the width of footway is sufficient to avoid conflicts even at low flow rates.

3.1.10 Our methodology for evaluation of the flow rates, Level of service, and whether there is sufficient clear width for flow in the various options has been to:

- Determine forecast for crowd flows (people/minute) during the peak 15 minutes in the vicinity of the stadium for the options being considered. The forecast is based on the Transport Assessment (which describes when and where people arrive into the area, what local facilities they use in the local area and the time profile over which they arrive in the immediate vicinity of the stadium); their ultimate destination in the stadium, and the use of the Club shop;

- Determine the effective widths of the walkways for the walkway under consideration by reducing the width to take account of obstructions in the walkways and edge effects;
- Determine flow rates (people/metre/minute) by dividing flows by the effective widths of the walkway;
- Relate flow rates to the conditions experienced by pedestrians (e.g., whether there are likely to experience conflict) using the concept of Level of Service; and,
- Determine whether this Level of Service is acceptable for the option under consideration.

3.1.11

We have then considered whether the options presented create other crowd safety risks arising from mitigation measures.

3.1.12 Two sets of guidance were considered in our crowd flow and safety evaluation.

3.2 Fruin Levels of Service



3.2.1 The Level of Service concept for pedestrian flow was developed by Professor Fruin, (described in Pedestrian Planning and Design, Fruin, 1971) and is the most widely applied basis of quantitative assessments of crowded places. The concept relates crowd density, flow rates and pedestrian experience. It forms the basis of standards applied in different types of buildings and places, particularly those applying to high crowd flow environments, for example London Underground's Station Planning Standards and Guidelines. The Guide to Safety at Sports Grounds guidance, published by the Sports Grounds Safety Authority, includes crowd densities and flow rates in its guidance.

3.2.2 Fruin describes six Levels of Service for walkways (as opposed to stairs or queuing areas) which are illustrated in Fig. 5 over the page.

Figure 9 Pedestrian Planning & Design, John J Fruin, 1971 available from [Elevatoorbooks.com](http://www.elevatoorbooks.com)

3.3 TfL Pedestrian Comfort Guidance for London

3.3.1 In 2010 Transport for London published its Pedestrian Comfort Level Guidance, 2010, to assist those planning London's streets to create excellent pedestrian environments. It can be downloaded from <https://tfl.gov.uk/cdn/static/tfl/assets/documents/pedestrian-comfort-guidance-technical-guide.pdf>.

3.3.2 Its focus is on the space needed to facilitate a successful street, in terms of comfort and experience, and therefore usage, rather than a focus on safety. Its guidelines apply to places that require more space than places designed for crowd flow (such as stadium vomitories). Its scope is equivalent to Fruin Levels of Service A to C, i.e., the more comfortable, lower flow rate environments.

3.3.3 As well as a set of Levels of Service (different and more generous in space/person terms than Fruin's) the Guidance includes more detail than Fruin of the real impact of street furniture based on measurements in London, and the recommended minimum widths for pavements.

² Health and Safety Executive website; <http://www.hse.gov.uk/frisk/theory/alarp/alarp.htm>



Level of Service A

Flow rate: 0-23 p/m/min
Density: > 3.23 m²/person

Normal walking speed can be freely selected and slower pedestrians can be overtaken easily.
Crossing conflicts can be easily avoided.



Level of Service B

Flow rate: 23-33 p/m/min
Density: 3.23 - 2.33 m²/person

Sufficient space is available to select normal walking speed and to bypass other pedestrians in primarily one-directional flows. Where there are reverse-direction or crossing movements, minor conflicts will occur.



Level of Service C

Flow rate: 33-49 p/m/min
Density: 2.33 - 1.39 m²/person

Restricted ability to select normal walking speed and pass others. High probability of conflict where crossing movements and counter-flows exist. Conflict avoidance requires frequent adjustment of walking speed and direction. However flow is reasonably fluid.



Level of Service D

Flow rate: 49-66 p/m/min
Density: 1.39-0.93 m²/person

Restricted walking speed. Overtaking is difficult, cross-flows are restricted. There is some probability of intermittently reaching critical density, causing momentary stoppages of flow.



Level of Service E

Flow rate: 66-82 p/m/min
Density: 0.93 - 0.46 m²/person

Restricted walking speed and passing ability. Forward movement only by shuffling. Counter-flows and crossing movements extremely difficult. Flow volumes approach limit of walking capacity.



Level of Service F

Flow rate: restricted, lower than LoS E
Density: <0.19 m²/person

Severely restricted walking speed. Frequent contact. Cross-flows are virtually impossible. Pedestrian flow is sporadic & unstable.

Figure 10. Fruin Walking Levels of Service

3.3.4 MS has concluded from a consideration of Fruin that the appropriate target to reduce risk ALARP should be the limit of Fruin LOS A/B (if practicable) and otherwise LOS B provided there is sufficient footway width for minor conflicts to occur without the requirement to step off the pavement. Fruin states that at LOS B there is sufficient space to select normal walking speeds and to bypass other pedestrians in primarily one-directional flows, as is the case outside 746 – 750 High Road in some of the future schemes considered. However, conflicts would still occur considering the high prevalence of groups in a stadium crowd.

3.3.5 At LOS C there is a restricted ability to select normal walking speed and pass others, and consequently a high probability of conflict, and pedestrians will be likely to walk in the road.

3.4 TfL Pedestrian Comfort Guidance for London: Pedestrian Comfort Levels



Figure 11 Transport for London's Pedestrian Comfort Guidance: Page Pedestrian Comfort Levels

- 3.4.1 Levels PCL A and B would meet the objective of reducing the risk of conflicts to acceptable levels. However PCL A and B are only achievable with very low flow rates which it is not practicable to achieve in the vicinity of a stadium.
- 3.4.2 A lower PCL rating will mitigate the risk ALARP provided that there is sufficient space and opportunity for pedestrians to avoid conflict without stepping into the road. A low rating would therefore require a sufficiently wider footpath.
- 3.4.3 In these circumstances it is considered that an appropriate target to mitigate the risk ALARP is PCLC. PCL D and E will not mitigate conflicts sufficiently to reduce the risk to ALARP and are therefore unacceptable, without further mitigation to prevent people walking into the road.
- 3.5 Conclusion
- 3.5.1 From a consideration of both standards Fruin LOS A/B equivalent to PCL Guidance C has been identified with a target flow rate of 23p/m/min together with sufficient width in order to reduce the identified crowd safety risk to ALARP.

3.6 Usable widths of footpaths

The measured width of the footpath does not represent the effective width for considering crowd safety issues. Where there is no street furniture or obstructions, the usable walkway width is the total width less a 200mm edge effect on each side. This accounts for people not wanting to walk too close to a building or kerb line.

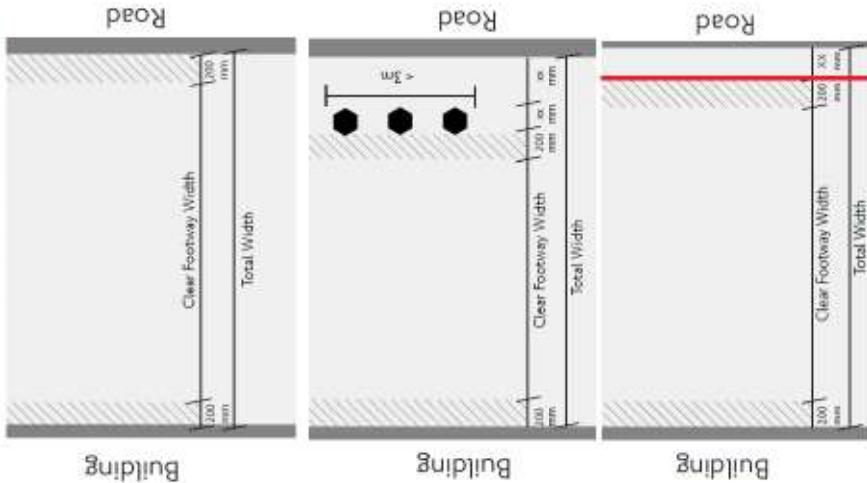


Figure 12. Pedestrian Comfort Guidance on effective usable walkway width to calculate Level of Service

3.7 Minimum widths of footpaths

The Transport for London Pedestrian Comfort guidance copied in Figure 13 below suggests minimum widths for walkways. The forecast non-event weekday evening flow of 640 people per hour puts the current footpath outside 748 and 750 High Road into the Active Flow category. This would require a minimum of 3.3m, or 4.2m if there is street furniture present. Therefore the current footpath is not compliant with the Transport for London Guidance even on a non-event day.

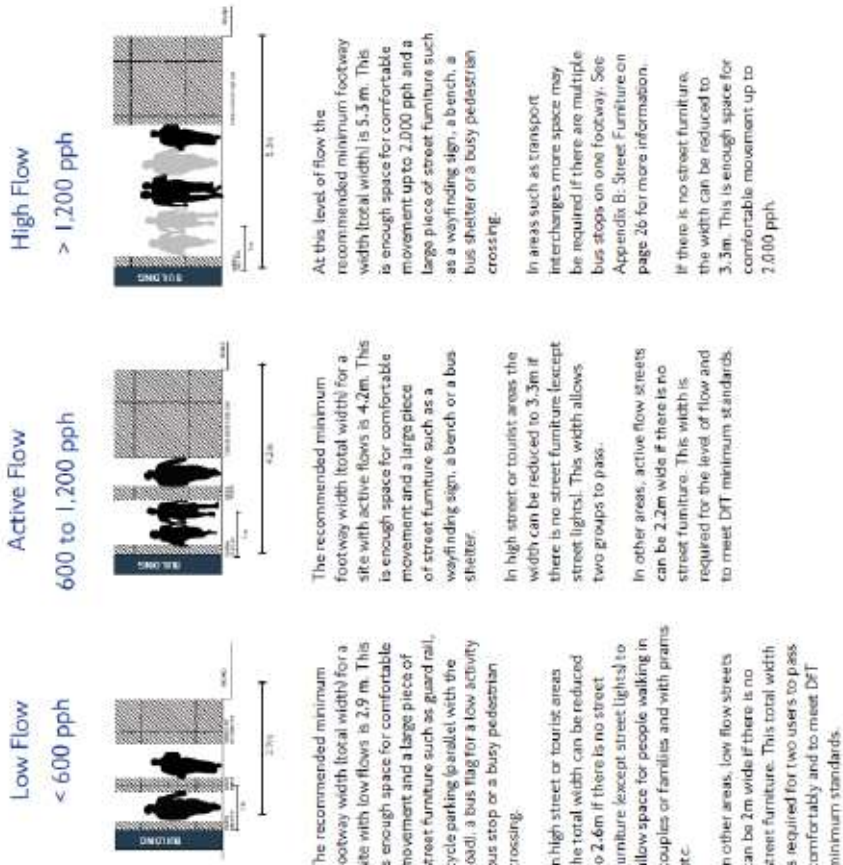


Figure 13. Transport for London Pedestrian Comfort Guidance Page 25: Recommended Widths

4.0 Evaluation of the Proposed and Approved Schemes

- 4.1 In this section we evaluate the Consented Scheme and the proposed Populous scheme against the identified standards and safety considerations.
- 4.1.1 This evaluation is based on estimates of the future crowd flows set out in the Major Event Day Transport Assessment 2015.
- 4.2 Flows considered in this analysis
- 4.2.1 The following crowd flows have been considered in this analysis
- General attendance spectator movements from transport hubs and local pubs to the stadium seating areas; and
 - Flows to and from the Club shop.
- 4.2.2 The forecasts do not include any flows associated with:
- VIP Spectators who are considered to have entered the stadium outside the peak period; and
 - Background pedestrian demand.
- 4.2.3 The flows do not consider the additional effects of the use of the three buildings for food and beverage uses. The reactivation of these buildings would only increase crowd flow in this area. In addition there would be an inherent conflict between the proposed use of the canyon for general spectator movements with people entering/leaving the buildings particularly if there are large numbers of people drinking outside. The proposed re-use of the three buildings is therefore only likely to act as a further deterrent from the use of the canyon and increase the crowd flow along the High Road in front of the buildings.

4.3 Time Profile

- 4.3.1 The Transport Assessment identifies a weekday evening kick-off as the worst case crowd flow scenario. A future forecast arrival for a weekday evening match is set out below.

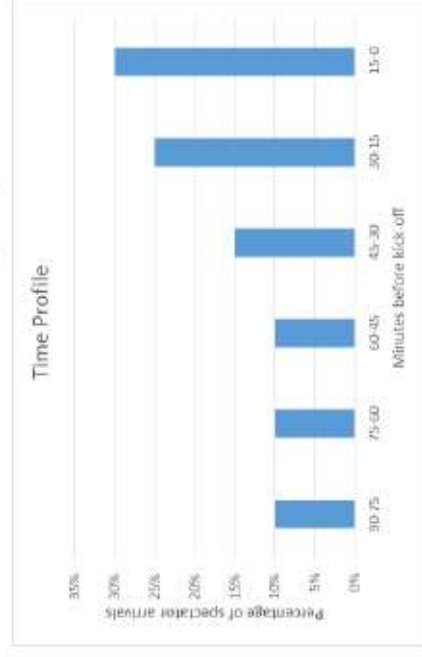


Figure 14 Future forecast arrival profile. Transport Assessment

- 4.3.2 The crowd flow analysis therefore focuses on the peak 15 minutes arrival during which 30% of people arrive. Figure 15 illustrates the peak flows arising in the Populous scheme.

4.4 The Populous Scheme

- 4.4.1 In order to reduce the risks arising from pedestrians moving into the road before a match the design has evolved by moving the Tottenham Experience east as far as possible while remaining consistent with the objectives of the scheme to maximise the available pavement width.

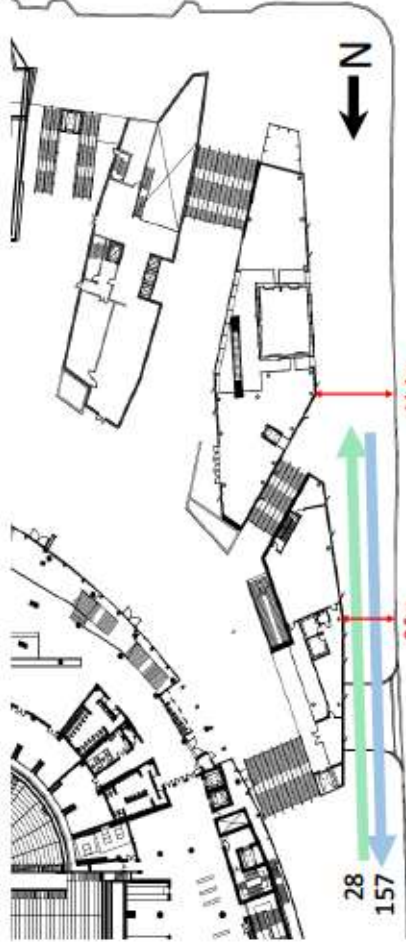


Figure 15 Forecast flows per minute past the bottleneck for the Populous Scheme

- 4.4.2 The forecast flow is 185 people per minute through the narrowest part of the footpath, which is 9.5m wide. This includes flows for access to and from the Club shop.
- 4.4.3 The scheme has bollards set back 0.45m from the edge of the road to allow for vehicle overhangs in accordance with the Manual for Streets. The bollards themselves would be 0.2m wide. A further 0.2m is subtracted from the effective width on the inside edge of the bollard and on the building edge. Thus the effective width is 8.45 metres wide.
- 4.4.4 In addition to this clear width, sited 0.85 metres from the road, there is an additional width between the road and the walkway. This increases the safety of the footpath as people would have to walk more than 0.85m outside of the effective clear width to be within the road.
- 4.4.5 With the forecast flow of 185 people per minute, the predicted flow rate would be 22 people per metre per minute.
- 4.4.6 This achieves the target flow rate of 23 people per metre per minute and the desired Fruin Level of Service A, and Pedestrian Comfort Level C. Taken with the increased width of footway, so that any manoeuvring is away from the walkway edge, the Populous scheme therefore reduces the crowd safety risk to ALARP.

4.5 The Consented Scheme

- 4.5.1 The Consented Scheme has been tested on the same basis. This assumes the retention of the three buildings, and the provision of a 'Canyon' to the rear of the buildings which is intended to divert flows away from the recognised pinch point along the High Road.

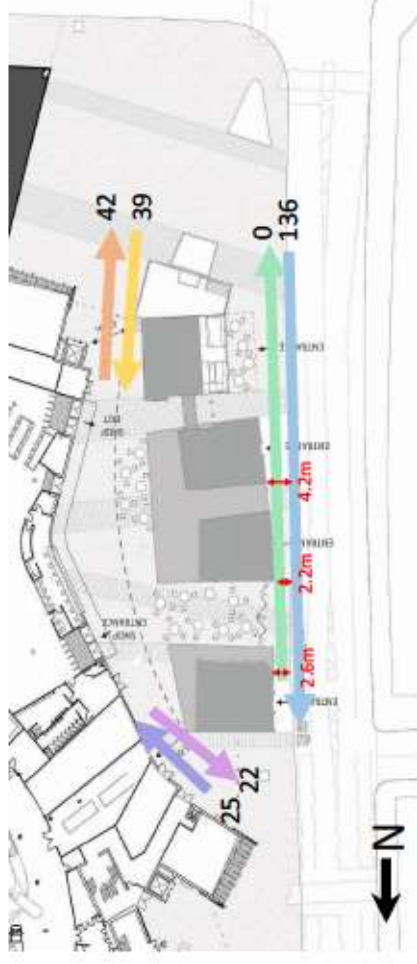


Figure 16 Forecast Flows per minute in the Consented Scheme

- 4.5.2 It is first necessary to identify the effective width for the Consented Scheme.
- 4.5.3 In the Consented Scheme, security bollards will be sited between the three buildings rather than between the locally listed buildings and the roadway.
- 4.5.4 The effective width in front of:
- 746 High Road is 3.8m
 - 748 High Road is 1.8m
 - 750 High Road is 2.2m
- 4.5.5 The forecast flow between Park Lane and the north of 750 High Road is 136 people per minute. Although this is shown as one-way, in practice there would be a small amount of contraflow similar to the survey North of Paxton Rd (see section 1).
- 4.5.6 A further 47 people per minute ($25 + 22$ p/min) would move between the north and the Club shop. Thus the combined flow to or from the north would be 184 people per minute. 81 people per minute ($42 + 39$ p/min) would move between the south and the Club shop. Thus the combined flow to or from the south of the stadium is 218 people per minute.
- 4.5.7 Based on the forecast flows and effective widths, the predicted flow rate in the Consented Scheme (in front of 746-750 High Road) is 76 people per minute per metre equivalent to Fruin Level of Service E. At this flow rate pedestrians are certain to walk in the road. The Consented Scheme does not therefore reduce risk to ALARP.
- 4.5.8 In order to achieve Level of Service A (23 people per metre per minute) the Consented scheme would need to provide a minimum footpath width of 6.4 metres – close to three times the width actually provided.

- 4.5.9 The above analysis assumes no general pedestrian movements through the canyon.
- 4.5.10 If some flows are diverted into the canyon, as was originally anticipated, the crowd flows on the footpath in front of the three buildings would decrease by the same volume to the level of flow through the canyon.
- 4.5.11 It is therefore necessary to consider the likelihood of general crowd movements through the canyon.
- 4.5.12 The route through the canyon is longer than the route along the High Road, without a clear line of sight to the end location, and off the desire line. There is no reason for spectators to do this unless they wish to wait for friends entering the Club shop or visiting the possible food and beverage outlets in the three buildings.
- 4.5.13 The additional flows generated by the reoccupation of the three buildings for food and beverage uses have not been taken into account in this assessment. In accordance with the commercial advice of DCL, the occupier demand for these units would be dependent on having outdoor areas for drinkers and smoking.
- 4.5.14 Furthermore the volume of demand for these units is likely to be high, and is effectively unconstrained. This presents a further problem of how to manage high volumes of spectators congregating in the canyon and the High Road. Access to the units and queuing would need to be managed so as not to have crowds creating congestion in the canyon. It would be difficult for this to be managed to allow the scheme to operate as intended.
- 4.5.15 As a consequence, the reuse of the three buildings would create additional flows and groups of spectators gathering to drink and/or waiting for friends which in turn would represent a further significant constraint to free flows through the canyon – acting as a deterrent.
- 4.5.16 Two examples showing the importance of designing for the desire line are shown below. Even in the case of very minor diversions, the evidence demonstrates that people will take the most direct route.



Figure 17 Design vs User Experience: the design needs to cater for the desire line

- 4.5.17 A further football example is the informal path created by fans approaching the Emirates Stadium through, Highbury Fields. These fans follow their own desire line, rather than the longer formal route on the path around the park, off the desire line. It is highly likely that a similar pattern would arise in the Consented Scheme.



Figure 18 Spectators on their way to Emirates Stadium in Highbury Fields



Figure 19 Satellite Imagery from Google Earth showing a route across Highbury Fields

4.5.18 Against this background the canyon will not sufficiently reduce crowd flow in front of the three buildings.

- 4.5.19 In order to achieve the target flow rate, 70% of the crowd flow would have to deviate through the canyon. For the reasons set out above MS do not consider that there is a realistic prospect of this percentage of pedestrians choosing to use the canyon.
- 4.5.20 By way of direct comparison as set out above it is predicted that the Populous scheme will achieve a flow rate of 22 people per metre per minute.
- 4.5.21 For the Consented Scheme to achieve the same flow rate as the Populous Scheme 71% of the crowd would be required to use the canyon.
- 4.5.22 Even in the unlikely event that this level of diversion could be achieved, the Consented Scheme would not be as safe as the Populous scheme for the following reasons:
- At low widths people are more likely to manoeuvre round others by walking in the road
 - There is a smaller physical margin at the walkway - road boundary – and not marked by bollards
 - There is less scope for further mitigation – this is explored in the options assessment
- 4.5.23 In conclusion it is MS's opinion based on these assessments that the Consented Scheme would not achieve the target flow rate and Level of Service necessary to reduce the volume of pedestrians walking in the road and would not therefore reduce the crowd safety risk to ALARP.
- 4.5.24 Furthermore it is MS's opinion backed up by empirical evidence and TfL Comfort Guidance that the 2.2m width provided in the Consented Scheme would be too narrow to be ALARP for a new stadium.

5.0 Alternative Options

- 5.1 Having concluded that the Consented Scheme would result in unacceptable crowd safety conditions, the team has examined alternative options to seek to retain the three buildings, to deliver the required levels of service and comfort levels, and to reduce risks to ALARP.
- 5.2 On the basis that our starting point has been to try to retain all the NDHA, the range of options tested is largely based upon the consented scheme, and how this could be adapted to make this scheme acceptable in crowd safety and transportation terms. We have also considered the viability and deliverability of each option.
- 5.3 The list of options is broadly in ascending order of physical intervention. The options analysed are in summary:-
1. The Consented Scheme with no crowd management
 2. The Consented with barriers and stewarding and policing
 3. The Consented Scheme with temporary closure of the Southbound bus lane
 4. The Consented Scheme with permanent closure of the Southbound bus lane
 5. The Consented Scheme with the temporary closure of both Southbound lanes
 6. The Consented Scheme with the temporary closure of both Southbound lanes and contraflow on the Northbound carriageway
 7. The Consented Scheme moving High Road westwards
 8. The Consented Scheme and shared surface on the High Road
 9. The Consented Scheme with a tunnel the High Road
 10. The Consented Scheme and Flyover above the High Road
 11. The Consented Scheme and pedestrian Bridge/walkways over the three buildings
 12. The Consented Scheme with an increased Podium
 13. The Populous Scheme
- 5.4 The more radical options raise very significant issues in terms of their impact on viability, deliverability, programme, and ultimately in some cases are likely to cause significant harm to other heritage assets, but are included for the sake of completeness. A full evaluation of each option is set out in section 8.0.

6.0 Viability and Deliverability

- 6.1 In parallel with the review of technical flow and crowd safety issues THFC has considered the viability and deliverability of alternative options to retain the three buildings.
- 6.2 The delivery of the new stadium is a critical component of the wider regeneration strategy for the area, and in particular the requirements of THFC and the NFL. Any significant delay to the delivery of the scheme would severely prejudice the wider regeneration aspirations held by LB Haringey, the GLA and central government.
- 6.3 Notwithstanding these wider issues, the practical impact of retaining the three buildings requires careful consideration in the light of the detailed crowd flow analysis.
- 6.4 This report should be read in conjunction with the addendum report prepared by Davis Lyons Coffey, which considers the commercial viability of the reuse of the three buildings. The most appropriate, and only viable commercial use identified is for food and beverage uses.
- 6.5 The report sets out how the ground floor areas of each of the buildings would need to be accessed and arranged (including the need for associated outdoor space) in order to accommodate the requirements of food and beverage operators.
- 6.6 The provision of external spaces to the rear would have a significant impact on the canyon, which already represents a narrow space, illustrated by the section below.

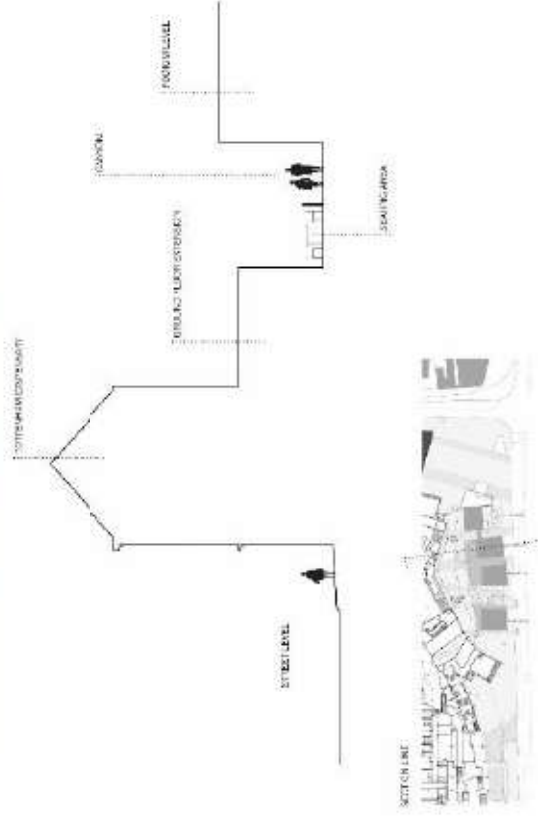


Figure 20 Cross-section showing the canyon

- 6.7 The way the buildings would need to be operated in order to accommodate viable uses has a material impact upon some of the options considered in the assessment, including for example:

- Any entrances to these buildings on the High Road would create additional flows through the existing constraints, and would create new counter- and cross-flows, both of which would exacerbate congestion, including on non-match days;
- On match days any crowds waiting or assembling outside entrances on the High Road would restrict flows and need to be managed (which would itself create congestion) to prevent people spilling into the road or further into the carriageway, which would be difficult to achieve;
- As a consequence, any entrances on the High Road would have to be closed on match days reducing commercial viability;
- External spaces and entrance/exits to external spaces in the canyon could be provided. However, these spaces (and therefore capacities) would have to be limited and contained to avoid congestion in the canyon. Severe congestion in the canyon would prevent spectators' access the stadium or the Club shop, and even less than severe congestion (including queuing for F&B) would encourage use of the High Road through the pinch point. Management controls would be needed to control access and any queuing in the event that demand is high, and it would be difficult in practice to prevent congestion for commercially successful F&B uses.
- On non-match days entrances / exits on the High Road would create cross-flows in a narrow pavement, which may push people into the road, when it is not expected by drivers of vehicles and buses. We have considered whether entrances on the High Road would be viable on non-match days for the options;
- 6.8 There is a fundamental conflict between the retention of the three buildings for their optimum (and only) viable use, and achieving acceptable crowd conditions which reduce risks to ALARP.
- 6.9 The evidence suggests that either the buildings would fail to attract occupiers capable of operating within the constraints imposed on the buildings and/or of the reuse would lead to unacceptable risks to public safety.
- 6.10 The closure of the bus lane and southbound lanes of the High Road would lead to significant traffic and highways issues, outlined in the following section.
- 6.11 The delays and uncertainty associated with seeking such controls, given the limited justification and wider impacts arising, would seriously affect the programme and delivery of the stadium and wider regeneration of the area.
- 6.12 The more radical options, involving the relocation of the High Road, provision of a tunnel/flyover or elevated bridge would all impose significant additional costs and delays on the scheme, even if feasible. The viability of the Project is marginal at present, and as a consequence any additional costs associated with such major infrastructure works would make the scheme unviable and unworkable.
- 6.13 Furthermore, even if a sound technical case could be put forward for such measures, the costs, delays, uncertainty and traffic and heritage impacts of those proposals would be entirely disproportionate to any benefits realised.
- 6.14 In practice, none of these options would be viable or deliverable. The only option which is deliverable, acceptable in highways terms, and which reduces risk ALARP is the Populous Scheme.

7.0 Transport

- 7.1 The preceding chapters explain the crowd safety risk that will arise in the Consented Scheme.
- 7.2 The assessment of any alternative proposal to resolve this issue needs to consider the impact on the transport strategy for the new stadium and the wider highway network.
- 7.3 The transport strategy is complex and relies on the full exploitation of the transport services on the High Road and in the Tottenham area generally. The stadium is being actively promoted as a 'Public Transport Destination'. On major event days there will be extensive parking controls in both Haringey and Enfield that will oblige spectators to switch to more sustainable transport modes. THFC has set a modal split target of 77% of football spectators arriving in the vicinity of the stadium by non-car modes.
- 7.4 The only compromise to this strategy is that the High Road is closed to all traffic during the busiest part of the post-event dispersal period.
- 7.5 The crowd safety issue that is the subject of this report therefore exists solely in the pre-game situation. Consideration has been given to the feasibility of closing the High Road before a match to seek to resolve the crowd safety issue.
- 7.6 After the match the auditorium is empty 10 minutes after the final whistle and only small numbers of spectators will remain in the building – mostly those enjoying corporate entertainment. Although one of the aspirations of the Stadium Travel Plan will be to retain a greater percentage of spectators in the stadium for a longer period after the end of the match.
- 7.7 The majority of spectators disperse from the local area very quickly and therefore the High Road is able to be re-opened 30 minutes after the final whistle depending upon advice from the police.
- 7.8 There is an unavoidable requirement to close the High Road for a short period to allow the spectators to disperse because of the location of the stadium immediately adjacent to a Strategic Road. This closure results in significant local traffic congestion which often takes an hour to clear.
- 7.9 In contrast before a match the stadium area becomes progressively busier over a longer time period – 90-120 minutes before kick-off depending on the day of the game and its significance. The issues of pre match crowd management and safety are compounded by spectators arriving, meeting, and drinking in the vicinity of the stadium before the game.
- 7.10 The closure of the High Road for a short 30 minute period before kick-off (replicating the position after a game) would not therefore resolve the crowd safety issue. In practice the High Road would need to be closed for a considerably longer period – likely to be at least two hours before a game.
- 7.11 The temporary road closure after the game requires the implementation of bus and general traffic diversion routes. The post-match closure is implemented 5 minutes before the final whistle and is easy to implement because the traffic and pedestrian levels at that time are generally quite low – in contrast to the situation before a game. These bus and general traffic diversion routes would need to be implemented before a match.
- 7.12 The existing bus diversion after the game takes the services a mile away from the stadium which is very inconvenient for general travellers and means that there are no post-match bus service available in the High Road corridor for spectators.
- 7.13 Whereas the current post match all-traffic diversion might only apply for 30 minutes after the final whistle, the buses divert to the east side of the stadium well in advance and don't return to a full service for over 1 hour after the game.

- 7.14 In all likelihood if the road was closed pre-match (together with the existing post-match diversions) the buses would never return to the High Road for the period between the closures.
- 7.15 In practice the bus diversions are likely to be operate for at least 4 hours every event day.
- 7.16 This would have significant implications for spectators, local residents reliant on these services as well as travellers using these routes to travel longer distances on the network but who would ordinarily pass through this stretch of the High Road.
- 7.17 Any proposal to close part or all of the High Road before a game, could result in traffic congestion over an extended period in the approach routes to the stadium. This congestion would arise at a time when the stadium is fully occupied and in the worst-case situation could persist for the full duration of the of the road closure – potentially over 4 hours.
- 7.18 This traffic congestion would result in disruptions to access to the stadium by emergency service vehicles. All 3 emergency services would be equally disrupted which would be a significant concern for the Stadium licensing body (Stadium Advisory Group as led by LBH Building Control). There will be a number of ambulances stationed on site but they could only deal with a small incident.
- 7.19 There will also be a police vehicle presence but those vehicles would need to be able to quickly move around the area to respond to calls for assistance. Fire tenders do not sit on site because they respond to calls from the fire station base and different incidents require different response vehicles.
- 7.20 Included below are two key plans which are proposed to be implemented with the new stadium to minimise the disruption caused by the short-term post-match closure of the High Road. The east side diversion for buses and general traffic is much shorter than the existing west side diversions by between 1 and 3 km. However, both would result in significant additional disruption.
- 7.21 The first priority is to divert buses by as little as possible in terms of travel distance and for the least possible time. Highway improvement works have been completed at the High Road junctions at Northumberland Park and Lansdowne Road to make the diversions possible in terms of the vehicle swept paths.
- 7.22 If the diversion was also to be pre-match the precise timings would determine the management strategy. However it would never be advisable to divert HGV's into what are residential areas.
- 7.23 If large number of cars were diverted to the east side over an extended period it would cause significant congestion for the diverted buses, which would defeat the object of the strategy.
- 7.24 The implementation of these proposed measures for the extended period would not therefore satisfactorily resolve the likely impacts on the wider transport network caused by the pre-match closure.
- 7.25 As a result the closure of part or all of the High Road before a game is likely to both prejudice the transport strategy for the stadium and adversely impact upon the wider highway network.



Figure 21 Traffic Diversion Routes



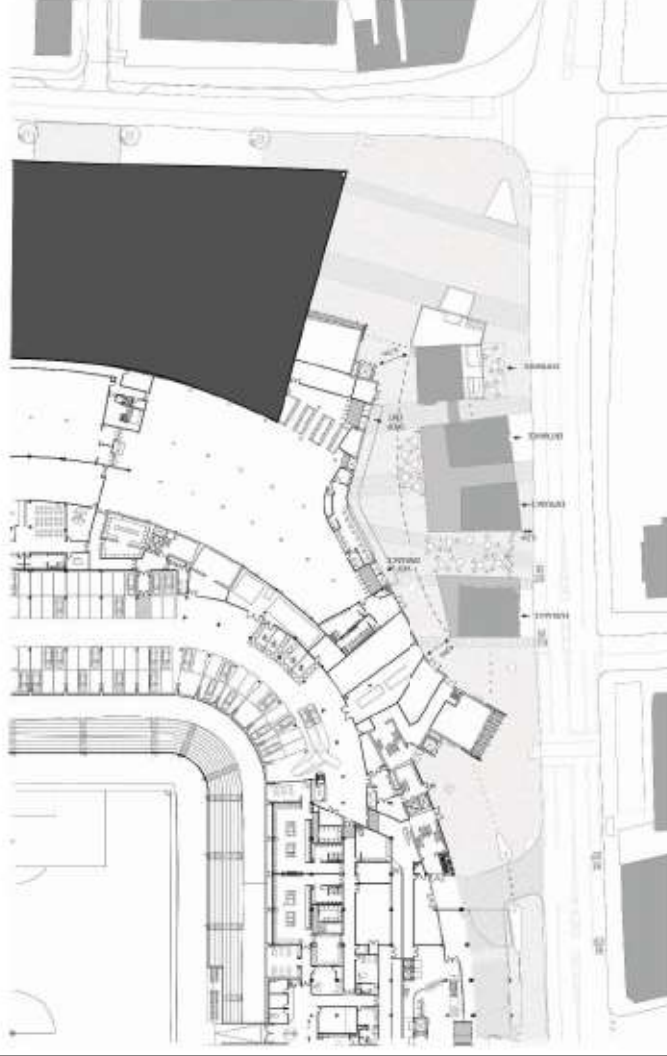
Figure 22 Bus Diversion Routes

8.0 Evaluation of Each Option

1. KSS Consented Scheme with No Crowd Management

OPTION SUMMARY

- The consented KSS scheme (HGY/2010/1000) with no additional crowd management.



Assessment

CROWD SAFETY

Assessment against Target Flow Rate:

The forecast for the flow per minute for the peak 15 minutes between Park Lane and the north of 750 High Road is 136 people per minute, (which excludes the flows for the Club shop), although this forecast excludes any demand created by provision of Food and Beverage.

This scheme is predicated on fans moving through the 'canyon' behind 744 - 750 High Road.

Assuming no diversion through the canyon and the flows along the High Road through a 2.2m width (1.8m considering edge effects) gives a flow rate of 76 people/metre/minute (Fruin LOS E).

At this flow rate pedestrians will be certain to walk in the road.

However, the spectators' desire line and shortest route is along the High Road, and most will continue to use that route.

It would require 70% of forecast match day flows to divert through the canyon to achieve LOS A/B.

It is very unlikely that this level of diversion would be achieved. The scheme will not therefore achieve the objective of reducing risks to pedestrian safety to ALARP.

If the three buildings are used for Food and Beverage retail then entrances/exits cannot be retained on the High Road on match-day due to increasing demand, congregation and cross flows on the High Road.

If access is provided to the rear than the external areas – and the capacity – of the three buildings would have to be limited and contained, to avoid congestion in the canyon. Access to the buildings via the canyon, and queuing outside the buildings would have to be controlled to prevent high volumes of spectators gathering outside the F&B units, and this would be difficult to achieve. This could block circulation through the canyon and access to the Club shop. Management of over-demand for the F&B units at the entrances to the canyon, while allowing access and circulation, would also be difficult to achieve.

The re-use of the buildings will also increase crowd flows and congestion in the canyon, which will deter pedestrians from using that route.

Additional safety issues:

The kerb edge is a trip hazard which adds the possibility of slip/trip/fall.

Even if the target flow rate was achieved the narrow footpath width means that pedestrians will step into the road to avoid conflicts made more likely by the presence of groups of spectators.

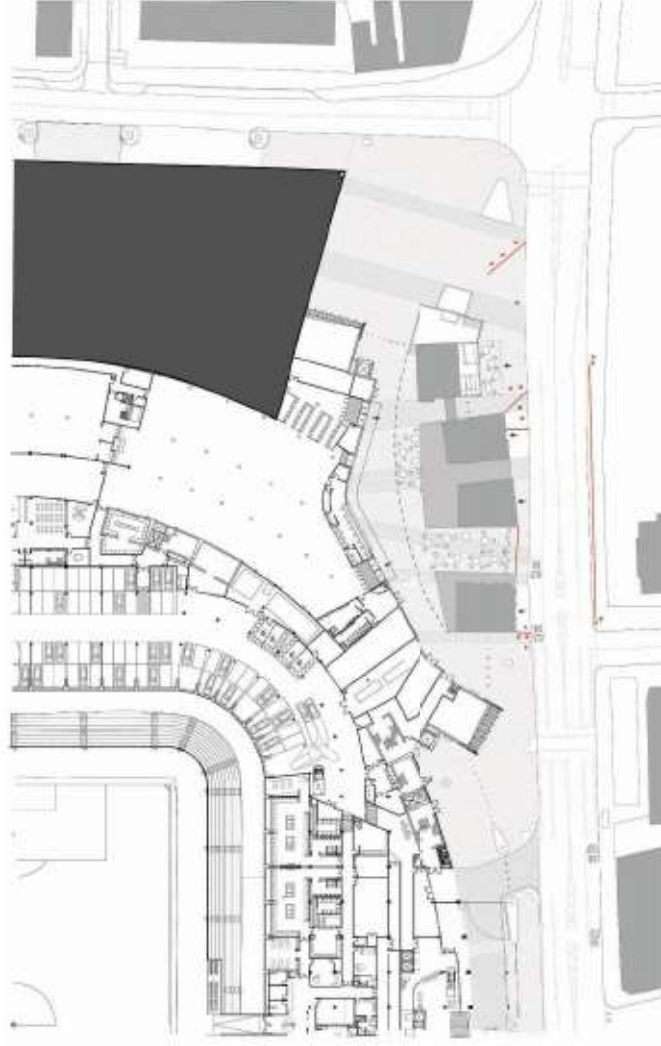
The width at the pinch point is less than recommended by the TFL Comfort Guidance section 3.6 (minimum 3.3m) for an 'Active flow' environment (>600 p/hr; 10p/min).

	HIGHWAYS AND TRANSPORT The existing southbound bus stop would need to be relocated further north perhaps to a point in front of the west side corporate spectator access or be removed without replacement.
	DELIVERABILITY This option depends on securing suitable occupiers for the three buildings. The optimum, and only viable use will be for F&B, and this use is dependent on match and event day trade. DCL advise that the units are currently too small to attract F&B operators (the only potential commercial occupier) without external space. The Crowd Flow Analysis demonstrates that entrances on the High Road are not viable in the base KSS option because of conflicts with crowd flow. They would exacerbate an already unacceptable and unsafe situation. External space in the Canyon will need to be limited and contained, with access managed and any queuing tightly controlled, which is likely to be difficult with risk that it cannot be achieved. This will impact upon the viability of the three buildings.
	CONCLUSION The scheme will not work as intended, with most pedestrians expected to continue using the High Road rather than the canyon and therefore not achieve the objective of reducing risks to pedestrian safety to ALARP. The footway width at the pinchpoint is less than recommended by TfL. 746-750 High Road do not appear viable.

2. Consented Scheme with Barriers & Stewarding & Policing

OPTION SUMMARY

- Consented scheme with insertion of physical barriers on eastern and western pavements enforced by stewarding and Policing to close stretch of pavement between 746 and 750 High Road.
- Formalise non-use of 'bus lane'.



Assessment

CROWD SAFETY

This management solution requires compliance from spectators and successful management over the lifetime of the project.

It contemplates 100% of the crowd flow using the canyon.

The predicted flow through the canyon in this option is 218 people/minute people, which includes football spectator flows associated with the Club shop (although flows for the Club shop during a NFL match are likely to be higher).

The Canyon is 6.7m wide less 0.4m edge effect. The predicted flow rate per metre is therefore 35 people/metre/minute representing LOS C.

Furthermore, this flow does not include any crowd flows or congregation associated with the use of three buildings for F&B. Access to the buildings from the High Road would be blocked on match day in this option.

The external areas - and the capacity - of the three buildings would have to be limited and contained, to avoid congestion in the Canyon. Access to the buildings via the canyon, and queuing outside the buildings would have to be controlled to prevent high volumes of spectators gathering outside the F&B units. This could block circulation through the canyon and access to the Club shop. Management of over-demand for the F&B units at the entrances to the canyon, while allowing access and circulation, would be difficult to achieve.

In any event spectators and other pedestrians will want to follow their natural desire line.

It will be difficult to achieve 100% compliance of spectators and other pedestrians using the canyon. It is very likely that some pedestrians will try to walk round the barriers, or move along the High Road from before the barrier line to bypass the system, or cross in the road demarcated by the barrier line.

When this occurs therefore will be a higher risk for the individuals than exists currently or as proposed in the Consented Scheme, as non-compliant spectators will have their attention focused on stewards rather than vehicles. Vehicle drivers will not expect pedestrians in the road, and stewards and police would also be at risk of conflict with vehicles if they step out to block the paths of non-compliant spectators.

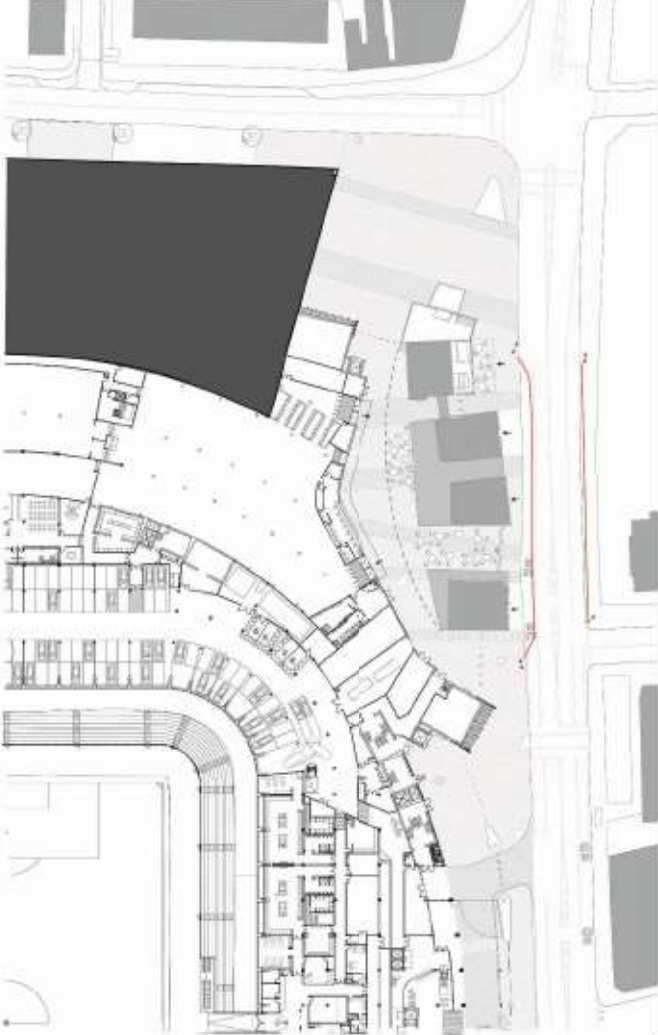
Even if 99% of spectators comply approximately 68 people will be in the road outside these buildings during the ingress period before each match.

The eastern footpath closure may cause increased use of the western footpath. Any people that choose to walk road-side of the western barrier there would find themselves stuck between vehicles and the barrier.

It will not be apparent to pedestrians why the diversion is necessary increasing frustration for people that have to walk further. Police and stewards would be instructing people to walk the long way around, off their desire line, and away from the path they can see goes where they want, to one with limited visibility. This may lead to some frustration/aggression from spectators in conflict with Police and stewards.

If the solution is not successful, the risk is built-in for the lifetime of the stadium.

	HIGHWAYS AND TRANSPORT The southbound bus stop would need to be relocated further north for example to a point in front of the west side corporate spectator access or be removed without replacement. The traffic management restrictions would need to be implemented at the very least an hour and a half before the start of the major event. DELIVERABILITY The same issues apply as Option 1. The introduction of barriers would remove any prospect of entrances/access to the three buildings from the High Road on match days, channelling all the through the Canyon. The resultant conflicts with crowd flow would require additional intensive management and may impact upon external space provided for each of the buildings. This would further undermine the commercial viability of these units for F&B operators. CONCLUSION This option relies on successful management and pedestrian compliance of spectators and other pedestrians throughout the lifetime of the project for pedestrians to not be on the road. This is very unlikely to be achieved. The scheme does not allow for access to 746-750 High Road from the High Road on match day. The use of 746-750 High Road as F&B will create significant crowd management issues, likely to make the scheme unworkable due to the risk of severe congestion in the canyon and on the High Road. The risks of this scheme are built in for the lifetime of the stadium and there is little opportunity to provide further risk mitigation should it be required It does not achieve the objective of reducing the risk ALARP
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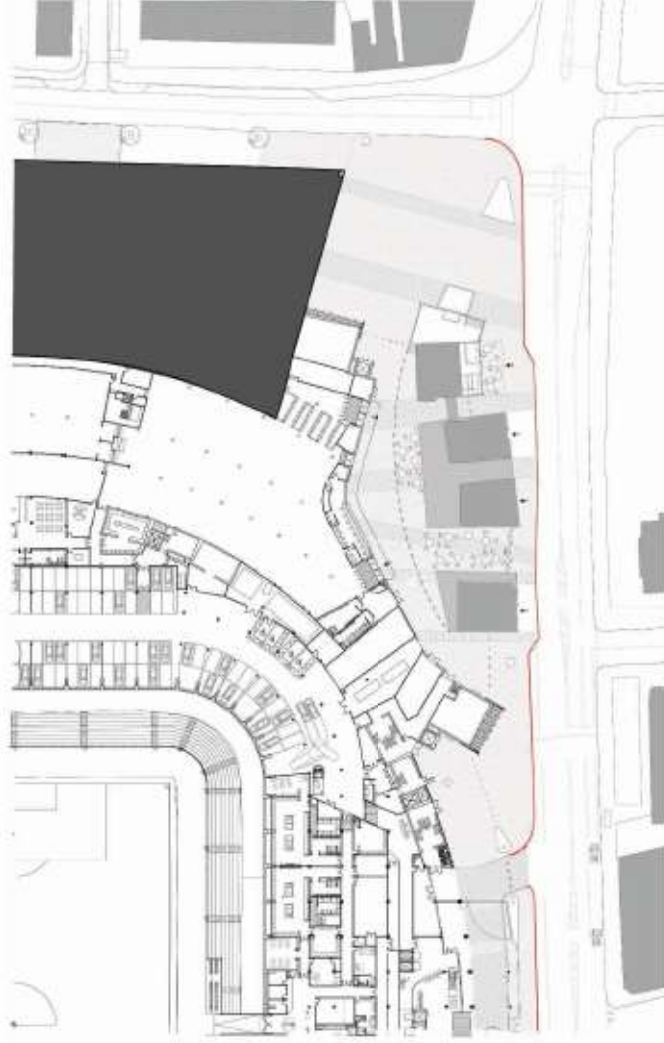
3. Consented Scheme with Temporary Closure of the Southbound Bus Lane	Assessment
OPTION SUMMARY - Consented scheme with temporary closure of southbound road both pre and post-match - Barriers at western edge of road supported by stewards - Temporary rerouting of bus services - Allows pedestrians to use 'bus lane' - Barriers along road 	CROWD SAFETY The narrow point would now be 5.2m wide outside 748 High Road. Accounting for a 0.4m edge effect, the usable width would be 4.8m. Subtracting a further 1m for a barrier set back from vehicle traffic 3.8m is available for crowd circulation. The forecast for the flow per minute for the peak 15 minutes between Park Lane and the north of 750 High Road is 136 people per minute, (which excludes the flow for the Club shop). The forecast flow of 136 people per minute through this bottleneck (assuming no diversion to the canyon) gives a flow rate of 36 people/metre/minute (Fruin LOS C). If there is some limited diversion via the canyon then the width could be LOS B. Although this forecast excludes any demand created by provision of Food and Beverage. This LOS is worse than the targeted LOS A. It is likely that some people would walk on the wrong side of the barriers putting themselves at increased risk. The temporary barriers proposed for this option would increase the risk for pedestrians who find themselves in the roadway. Those people would be stuck between barriers on both sides of the road and vehicles for over 60m. That would put them at increased risk of a severe collision with a vehicle. Whilst the number of people in the road way would be reduced by the barriers, the increased risk for those in the roadway would increase the risk overall. This option does not reduce the risk to ALARP. Additionally the kerb edge would form a trip hazard. With this management solution directing people to walk diagonally across and parallel to this level change, it is almost certain to cause minor injuries. This would be an unacceptable risk which would not be consistent with reducing the risk to ALARP. This trip hazard would require mitigation such as making the roadway at the same level as the kerb. Such mitigation would require TfL approval and would not be feasible. The kerb is necessary for the safety of pedestrians at times when the barriers are not in place to separate vehicles and pedestrians. Without the kerb some form of protection such as bollards, barrier or guard rail would be needed. The 2.2 metre width is already too narrow and would not be sufficient to accommodate bollards, barrier or guard rail. Entrances to 746 – 750 on the High Road would not be operationally viable due to the impact on crowd flow. The external space at the rear would have to be bounded to allow circulation in the canyon, and control of access and queuing to the rear of the buildings external space when demand is unconstrained would require crowd management to prevent the risk of severe congestion in the canyon. This would be difficult to achieve while allowing circulation and access to the Club shop The width at the pinch point is less than recommended by the TfL Comfort Guidance section 3.6 (minimum 3.3m) for an 'Active flow' environment (>600p/hr; 1.0p/min). HIGHWAYS AND TRANSPORT The temporary 50-60 metre kerb build out would interfere with the new proposed pedestrian crossing of the

High Road and the southbound bus stop. Buses would continue to use second southbound lane. Any additional traffic management measures/restrictions would result in a modest risk of causing local traffic congestion which would result in disruptions to access by emergency service vehicles. All 3 emergency services would be equally disrupted which would be a concern for the Stadium licensing body (Stadium Advisory Group as led by LB Haringey Building Control).	
DELIVERABILITY Access to the three buildings from High Road would not be achievable in this option. The requirement for external space to the rear still creates conflicts between the F&B use and the crowd flow through the Canyon. The external space at the rear would have to be bounded to allow circulation in the canyon, and control of access and queuing to the rear of the buildings when demand is unconstrained would require crowd management to prevent the risk of severe congestion in the canyon. As such, in terms of deliverability, there is no improvement on Option 1. The ability to secure a viable economic use for the three buildings is still uncertain.	
CONCLUSION This option relies on successful management and compliance of spectators and other pedestrians throughout the lifetime of the project for pedestrians to not be on the road. This is very unlikely to be achieved. It introduces additional risks for any spectators or other pedestrians not following the system, the vehicle drivers at risk of collision, and risks to the staff implementing the system. The option builds in a trip hazard, which is almost certain to cause minor injuries. It does not achieve the objective of reducing risk ALARP. The scheme does not allow for access to 746-750 High Road from the High Road on match day. The use of 746-750 High Road as F&B will create significant crowd management issues, likely to make the scheme unworkable due to the risk of severe congestion in the canyon. Therefore the operational and commercial viability of the use of 746-750 High Road for F&B is uncertain. The risks of this scheme are built in for the lifetime of the stadium and there is little opportunity to provide further risk mitigation should it be required.	

4. Consented Scheme with Permanent Closure of the Southbound Bus Lane

OPTION SUMMARY

- Consented scheme with permanent closure of southbound road
- Increase width of pavement in front of 746 – 750 High Road
- Permanent rerouting of bus services



Assessment

CROWD SAFETY

The narrow point outside 748 High Road would be 5.2m wide.

Accounting for a 0.4m edge effect, the usable width would be 4.8m. The forecast flow of 136 people per minute through this bottleneck gives a flow rate of 28 people/metre/minute (Fruin LOS B). This exceeds the proposed target flow rate.

The boundary of the walkway would be against the busier central road lane. People walking into this lane are at greater risk than people walking into the outside southbound lane in the other options.

People move to avoid pedestrian - pedestrian conflicts even at low flow rates so a risk remains during peak ingress periods.

Barriers and stewards could be introduced as further mitigation along both eastern and western pavements (this latter to stop informal crossing into a barrier on the eastern side) to manage this risk as per option 3.

However, introduction of barriers would reduce the available width and increase the flow rate, and creates risks described in other options: any non-compliant spectators or other pedestrians would now be forced into the main carriageways, where there would be more traffic.

Entrances to the three buildings from the High Road would not be viable for match-day as no queuing, waiting or congestion can be allowed on this stretch of walkway.

External space at the rear would have to be limited and contained to allow circulation in the canyon, and control of access and queuing to the rear of the buildings external space when demand is unconstrained would require crowd management to prevent the risk of severe congestion in the canyon. Queuing into the F&B would have to be controlled, while allowing circulation and access to the Club shop, which would be difficult to achieve.

HIGHWAYS AND TRANSPORT

The southbound nearside lane is painted red as a "bus lane" however it is available for general traffic at most times when there would be a major event at the new stadium. The operational hours of the north to south bus lane are 7am till 1pm Monday to Friday (and occasionally Saturday)

It is still a traffic lane used by a large number of buses and general traffic does tend to avoid the use of the bus lane even when it is not operational.

The removal of this lane to create a wider walkway, would need to satisfy highway design standards.

The longer permanent 100+ metre kerb build out would interfere with the new pedestrian crossing of the High Road and the southbound bus stop as well as removing the local bus priority at all times.

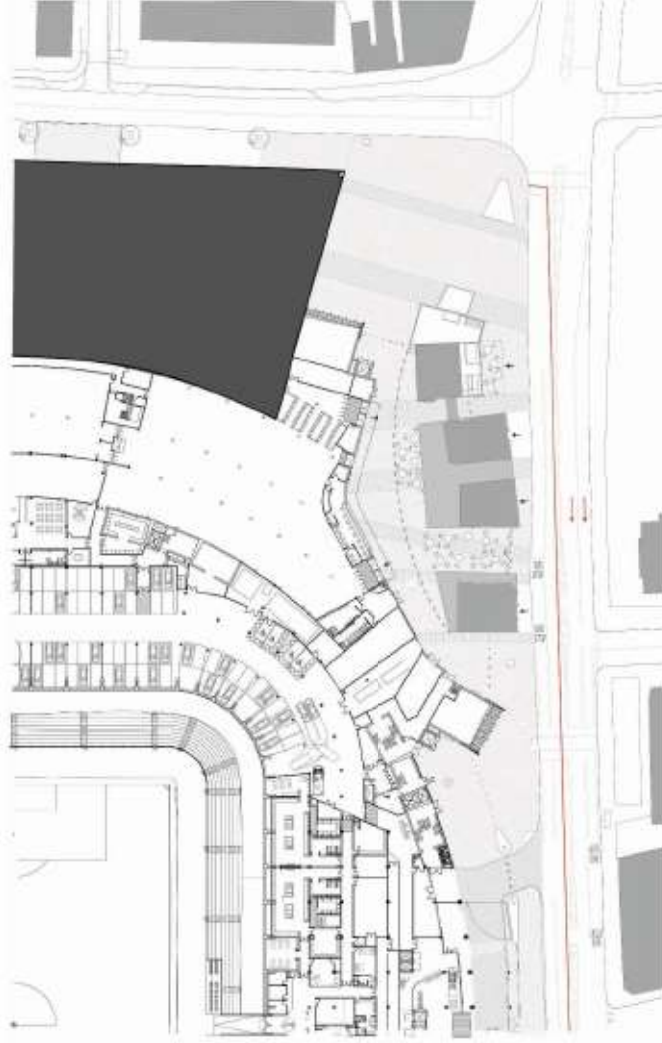
Any additional and permanent traffic management measures/restrictions would result in a significant risk of causing local traffic congestion which would result in disruptions to access by emergency service vehicles. All

	3 emergency services would be equally disrupted which would be a concern for the Stadium licensing body (Safety Advisory Group as led by LBH Building Control). The permanent removal of a section of the road to provide the increased walkway width would cause delays to each and every bus service which would amount to a substantial financial penalty in terms of social and economic dis-benefits. This section of the High Road is a strategically important bus corridor – particularly so given the level of use during the weekday commuter AM peak periods. DELIVERABILITY There is a marginal improvement as it creates more space in front of the three buildings outside event days, but the viability of reoccupying the buildings for F&B and their ability to operate satisfactorily in this option remains uncertain. CONCLUSION This option moves the pedestrian – vehicle boundary to the central carriageway, where any pedestrians straying into the road are at risk of pedestrian-vehicle conflicts. The conditions would be LOS B making it more likely that pedestrians will step into the road than other options. This can be managed by introduction of barriers and stewards, but then this retains the risk arising from spectator non-compliance as in option 3. It does not provide as much space or as low flow rates as other options. It does not achieve the objective of reducing the crowd safety risk ALARP. The scheme does not allow for access to 746-750 High Road from the High Road on match day. The use of 746-750 High Road as F&B will create significant crowd management issues, likely to make the scheme unworkable due to the risk of severe congestion in the canyon. Therefore the operational and commercial viability of the use of 746-750 High Road for F&B is uncertain. The risks of this scheme are built in for the lifetime of the stadium and there is little opportunity to provide further risk mitigation should it be required.
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5. Consented Scheme with Temporary Closure of Both Southbound Lanes

OPTION SUMMARY

- Consented scheme with temporary closure of southbound lane and road pre- and post-match
- Temporary increase in width of pavement to include road
- Re-routing of bus services and southbound vehicular traffic



Assessment

CROWD SAFETY

This would deliver a significant benefit for crowd flow.

The narrow point would now be approximately 8.2m wide. Accounting for a 0.4m edge effect, the usable width would be 7.8m. The forecast flow of 136 people per minute through this bottleneck gives a flow rate of 17 people/minute (Fruin LOS A).

The road-walkway boundary could be demarcated by a barrier, if required, in the second lane to provide a buffer vs. traffic however this would put people at risk of being stuck between the barrier and a vehicle lane.

On match day, entrances to 746 – 750 High Road would need to be controlled to prevent queueing and assembly outside the buildings on the High Road, which would require stewarding and be difficult in practice (itself likely to create congestion). There is also the problem of managing demand so that any queueing or waiting outside the buildings does not become unmanageable. Access to the front of the buildings is not recommended. There is a risk of congestion in the canyon, preventing access to the Club shop.

Additionally the kerb edge would form a trip hazard. With this management solution directing people to walk diagonally across and parallel to this level change, it is almost certain to cause minor injuries. This would be an unacceptable risk which would not be consistent with reducing the risk to ALARP.

This trip hazard would require mitigation such as making the roadway at the same level as the kerb. Such mitigation would require TfL approval and would not be feasible. The kerb is necessary for the safety of pedestrians at times when the barriers are not in place to separate vehicles and pedestrians. Without the kerb some form of protection such as bollards, barrier or guard rail would be needed. The 2.2 metre width is already too narrow and would not be sufficient to accommodate bollards, barrier or guard rail.

The width at the pinch point is less than recommended by the TfL Comfort Guidance section 3.6 (minimum 3.3m) for an 'Active flow' environment (>600p/hr; 10p/min) on non-match-day.

HIGHWAYS AND TRANSPORT

Pre-match bus diversions to the west of the stadium (the existing post-match diversion) would result in increased operating costs and reduced passenger revenue.

Pre-match bus diversions to the east of the stadium (a modified diversion) would also result in increased operating costs and reduced passenger revenue. It is very unlikely that diverted bus services would ever return to the High Road during the major event.

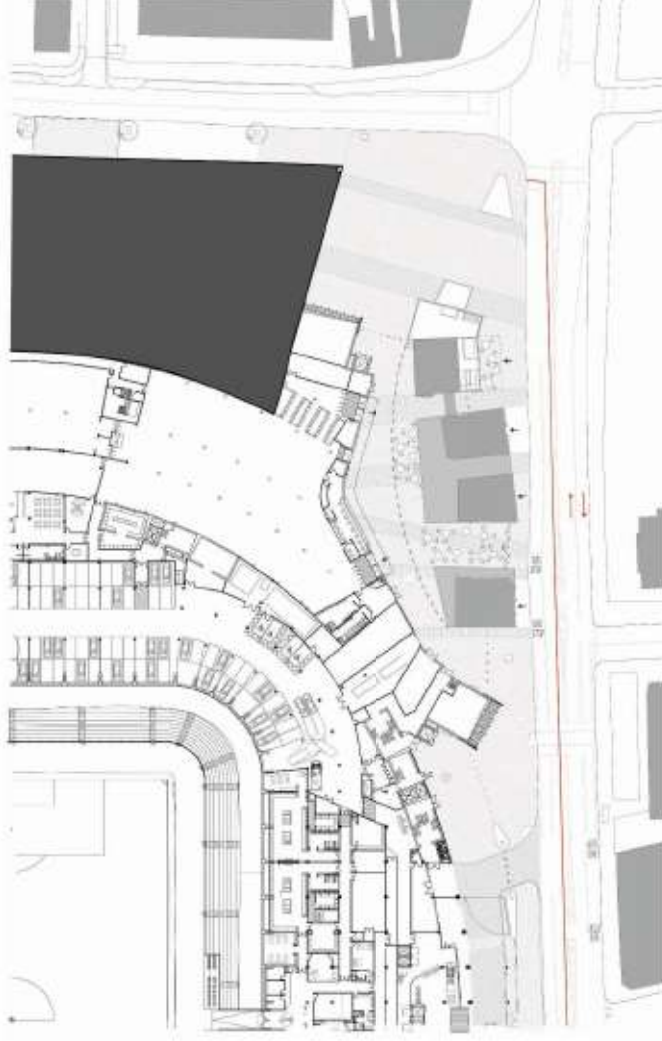
This would be an issue at any time but particularly in the tail of the weekday evening peak hour. The priority of the bus operator is to maintain the bus frequency, per hour, and average waiting time, minutes per bus. This is particularly the case for the much longer west side diversion. The west side bus diversion would render the services unusable by spectators pre-match which would undermine the major event transport strategy.

	Up to 10% of spectators are expected to use scheduled bus services pre-match. The west side diversion takes services away from the regeneration area which would result in considerable 'accessibility' difficulties if the diversion was to last up to 4-5 hours. The use of the shorter east side bus diversion would not materially reduce the timescale and inconvenience of the bus diversions. Any additional traffic management measures/restrictions would run a very high risk of causing considerable local traffic congestion which would result in disruptions to access by emergency service vehicles. All 3 emergency services would be equally disrupted which would be a significant concern for the Stadium licensing body (Stadium Advisory Group as led by LBH Building Control). DELIVERABILITY As Option 3. This option also depends on the ability to secure the necessary consent for the temporary closure of both southbound lanes, which would be challenging given the issues outlined above. This would also present uncertainty and delay in respect of the delivery of a workable solution. CONCLUSION This delivers benefits for crowd flow, but the introduction of a level change introduces risk and the proposal does not reduce risk to ALARP. The option would have a significant detrimental impact on the wider transport issues and in particular the overall transport strategy for the stadium.
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6. Consented Scheme with Temporary Closure of Both Southbound Lanes and Contraflow on Northbound Carriage

OPTION SUMMARY

- Consented scheme with temporary closure of southbound lane and road pre- and post-match
- Temporary increase in width of pavement to include road
- Contraflow introduced on northbound carriage to allow for two way flow of traffic



Assessment

CROWD SAFETY

This would deliver a significant benefit for crowd flow. The narrow point would now be approximately 8.2m wide. Accounting for a 0.4m edge effect, the usable width would be 7.8m. The forecast flow of 136 people per minute through this bottleneck gives a flow rate of 17 people/minute (Fruin LOS A).

The road-walkway boundary could be demarcated by a barrier, if required, in the second lane to provide a buffer vs. traffic.

On match day, entrances to 746 – 750 High Road would need to be controlled to prevent queuing and assembly outside the buildings, which would require stewarding and be difficult in practice (itself likely to create congestion). There is also the problem of managing demand so that any queuing or waiting outside the buildings does not become unmanageable. Access to the front of the buildings is not recommended. There is a risk of congestion in the canyon, preventing access to the Gub shop.

Additionally the kerb edge would form a trip hazard. With this management solution directing people to walk diagonally across and parallel to this level change, it is almost certain to cause minor injuries. This would be an unacceptable risk which would not be consistent with reducing the risk to ALARP.

This trip hazard would require mitigation such as making the roadway at the same level as the kerb. Such mitigation would require TfL approval and would not be feasible. The kerb is necessary for the safety of pedestrians at times when the barriers are not in place to separate vehicles and pedestrians. Without the kerb some form of protection such as bollards, barrier or guard rail would be needed. The 2.2 metre width is already too narrow and would not be sufficient to accommodate bollards, barrier or guard rail.

The width at the pinch point is less than recommended by the TfL Comfort Guidance section 3.6 (minimum 3.3m) for an 'Active flow' environment (>600p/hr; 10p/min) on a non-match day.

HIGHWAYS AND TRANSPORT

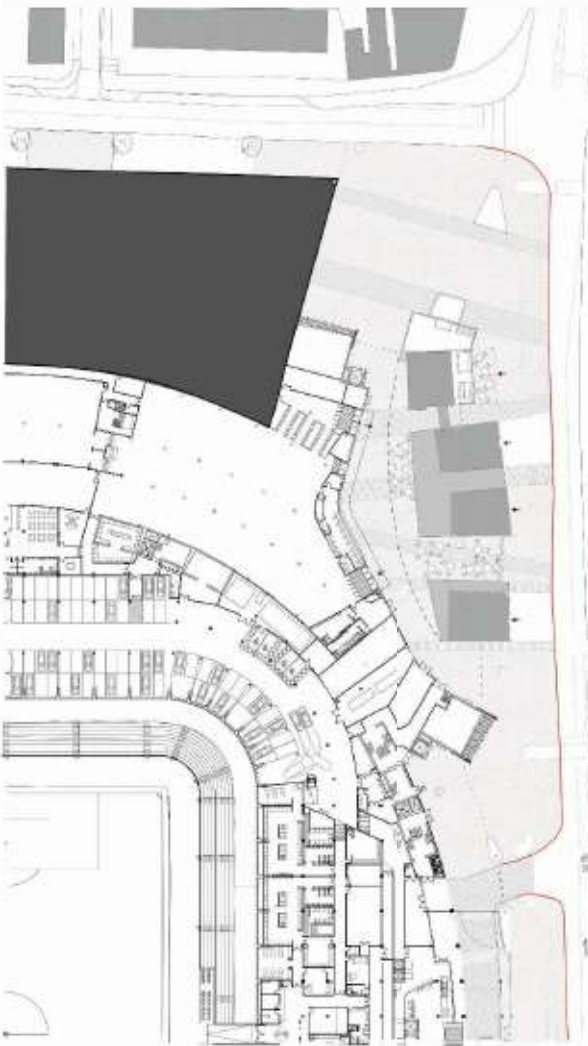
Southbound traffic cannot operate safely as a contra-flow within the northbound carriageway without causing considerable congestion and safety issues.

The existing northbound traffic lane is too narrow to allow temporary 2-way operation so the carriageway would need to be significantly widened coupled with removable street furniture such as, guard railings, traffic islands and traffic signal poles.

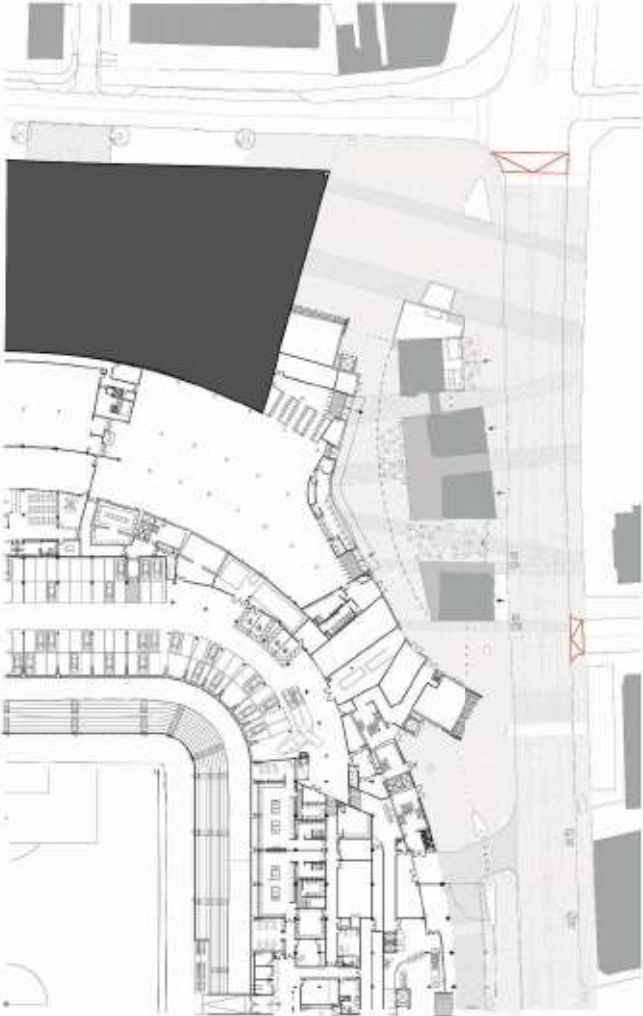
All the traffic lights would need to be turned off and covered and the temporary centre line would need to be coned/barriered – there is insufficient width available to do this without undermining the benefit to pedestrians of the temporary carriageway closure

The traffic management restrictions would probably need to be put in place and removed overnight when traffic flows are very low. This would therefore involve the all day closure of the roads and bus stops which would be a particular problem for TfL with regard to midweek fixtures.

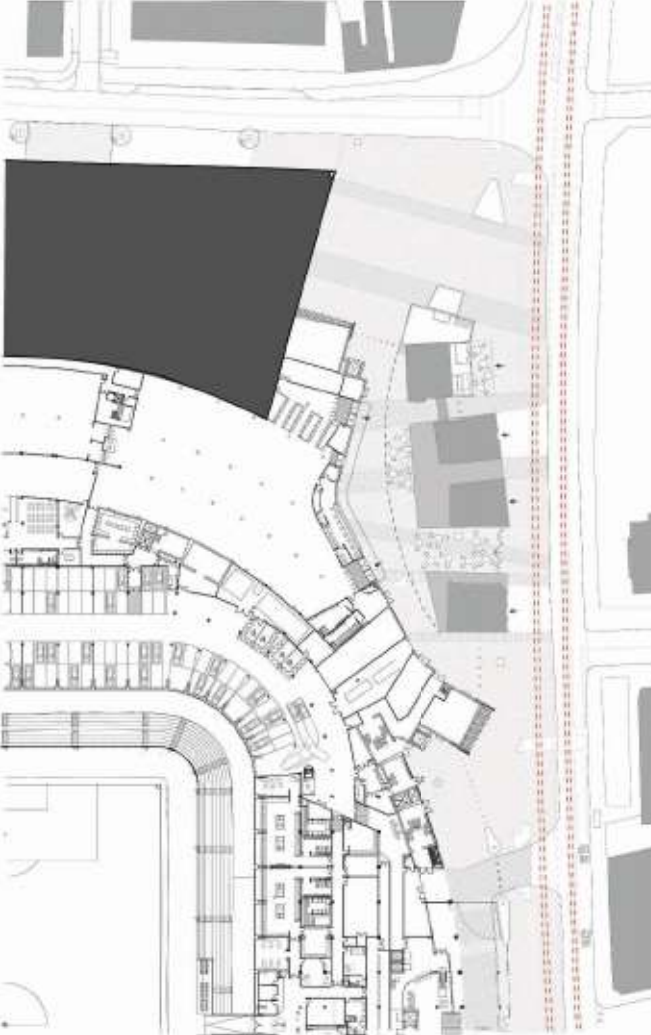
	Any additional traffic management measures/restrictions would run a very high risk of causing considerable local traffic congestion which would result in disruptions to access by emergency service vehicles. All 3 emergency services would be equally disrupted which would be a significant concern for the Stadium licensing body (Stadium Advisory Group as led by LBH Building Control).
	DELIVERABILITY As Option 3. This option also depends on the ability to secure the necessary consent for the permanent closure of both southbound lanes, which would be very challenging given the issues outlined above. This would also present uncertainty and delay in respect of the delivery of a workable solution
	CONCLUSION This delivers benefits for crowd flow, but the introduction of a level change introduces risk and the proposal does not reduce risk to ALARP. This option would have a considerable detrimental impact on the highways network and on the transport strategy for the new stadium

7. Consented Scheme and Move High Road Westwards	Assessment
OPTION SUMMARY - Consented scheme with increased footpath width on eastern side outside 746 - 750 High Road - Alignment of High Road moved further westwards 	CROWD SAFETY Potentially of significant benefit if the High Road is moved far enough west. If the road is moved 5m west and there are no entrances to 746 - 750 High Road on the High Road then the scheme would provide similar flow rates to the Populous scheme. With 5m additional width, the total width would be 7.2m at the narrowest point (6.8m considering edge effects). This gives a flow rate of 20 people/metre/minute. On match day, entrances to 746 – 750 High Road would need to be controlled to prevent queuing and assembly outside the buildings, which would require stewarding and be difficult in practice (itself likely to create congestion). There is also the problem of managing demand so that any queuing or waiting outside the buildings does not become unmanageable. Access to the front of the buildings is not recommended. Congestion in the canyon due to high demand for F&B units would inhibit access to the Club Shop/ HIGHWAYS AND TRANSPORT There is a strong likelihood that the recent TfL design guidance would support much wider walkways for 365 day activity levels on both sides of the High Road so the impact on existing buildings on the west side of the street might be even greater than shown in the sketch.

	DELIVERABILITY This improves the commercial attractiveness of the three buildings. However the cost of delivery in terms of highways, utilities, land assembly, and likely impact on other heritage assets make this option undeliverable. It would also impact upon LB Haringey's wider regeneration aspirations for the High Road West area. This option would fundamentally change the nature of the street, changing the road's historic alignment and would require the removal of designated heritage assets on the west side of the High Road. This would be very harmful to the North Tottenham Conservation Area. There would not be sufficient justification to promote the necessary compulsory purchase order, even if commercial viable. CONCLUSION This option would potentially resolve the crowd safety issue but in practice is likely to be undeliverable <u>and</u> would have a greater detrimental effect on the North Tottenham Conservation Area that the proposed Populous scheme. Access to 746-750 High Road used as F&B could be allowed depending on the width available at the front but management of queuing would need to be tightly controlled, which would be difficult if demand is unconstrained. No congregation in the front of the building could be allowed. Constraints would reduce the building's viability.
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8. KSS Consented Scheme and Shared Surface on High Road	Assessment
OPTION SUMMARY KSS scheme with shared surface on High Road from Park Lane to White Hart Lane 	CROWD SAFETY As per the Highways and Transport assessment below, a shared space scheme is not feasible on a match day. Pedestrians would fill the road and present significant risks of pedestrian-vehicle conflicts, particularly if drivers are frustrated by delays. Crowd congregation, associated with use of 746-750 High Road for F&B, could not be allowed as it would interfere with traffic. HIGHWAYS AND TRANSPORT The High Road is a busy and highly regulated street so the light touch shared surface approach would be very dangerous. This would result in substantial numbers of road traffic accidents with the existing level of use of the High Road. High frequency bus services and large pedestrian crossing movements require proper management and regulation. In the pre-event period it is likely that the dominant pedestrian movements would take control of the street and this would result in traffic gridlock. The High Road traffic flow next to the four building on a typical weekday is over 20,000 vehicles a day including substantial number of buses, coaches and commercial vehicles. This street is not a candidate street for the same shared surface approach adopted at Exhibition Road in Kensington where there are very few buses, coaches or commercial vehicles. The High Road hourly traffic flows on a weeknight from 6:45 to 7:45, the minimum pre-match traffic management period as assessed in this report, are as follows; Total vehicles – 1042 (including 84 cyclists) Car/taxis – 802 Light Goods Vehicles – 85 Medium Rigid Commercial Vehicles – 3 Articulated HGV – 0 Buses and Coaches – 77 (1 every 47 seconds) Motorcycles - 27 Any additional traffic management measures/restrictions would run a very high risk of causing considerable local traffic congestion which would result in disruptions to access by emergency service vehicles. All 3 emergency services would be equally disrupted which would be a significant concern for the Stadium licensing body (Stadium Advisory Group as led by LBH Building Control).

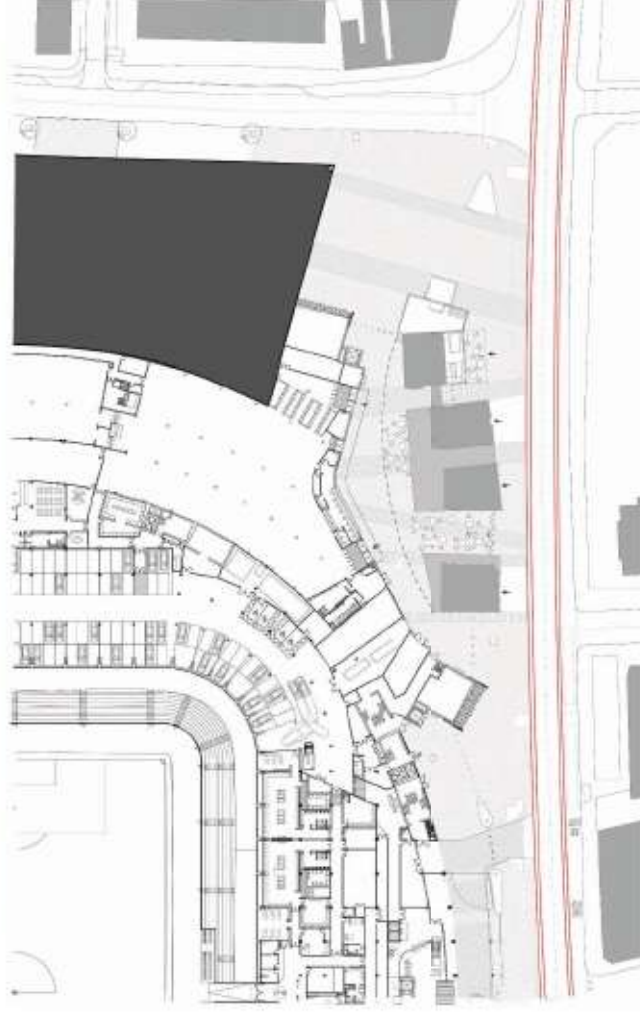
	DELIVERABILITY The viability of three buildings could be marginally improved in this option however for the crowd safety and highways issued described above it is not deliverable.
	CONCLUSION This option is not feasible for the High Road. It would give rise to even greater risk of pedestrian-vehicle conflict and would result in traffic gridlock before a game.

9. Consented Scheme and Tunnel the High Road	Assessment
OPTION SUMMARY Consented scheme with vehicular traffic diverted under a tunnel to increase pavement width at ground floor level 	CROWD SAFETY It is assumed that one vehicle lane in each direction would remain, and that this would carry local traffic only. The relative density of vehicles in the tunnel and above ground is not yet known. The alignment of the remaining lanes would provide need to provide additional walkway width to the eastern side of the High Road, sufficient to provide capacity for spectators to move without the need to move into the road. If the two remaining vehicle lanes are aligned with the central lanes now but wider, then the additional width would be less than that provided by the road, suggesting that the alignment would need to be towards the western pavement. Barriers (and supporting stewarding) may still be required to demarcate the pedestrian-vehicle boundary. HIGHWAYS AND TRANSPORT It would be very difficult to locate the tunnel portals to the north and south without extensive demolition of existing buildings. The tunnel section would be very expensive to build and would disrupt existing utility services. It would take many years of highly disruptive construction to implement even with the simplest cut and cover option. The local traffic and bus services would remain at grade in a 2 lane carriageway which would need to be almost as wide as the existing 4-lane cross-section. DELIVERABILITY This would change the nature of the street and would significantly harm this Conservation area (and potentially others) as well as any HAs in the vicinity of the tunnel entrances. While adjacent to the application site a tunnel would lead to an improvement of environmental conditions, at the entrances it would fundamentally harm the townscape, changing the relationship with the road and the buildings flanking it. Leaving aside the technical issues involved, and the delay and uncertainty in securing the necessary consent, the cost of this option makes it unviable, and disproportionate to any benefits. CONCLUSION This option is considered undeliverable. In any event it is likely to have a significantly more harmful impact in heritage terms than the Populous Scheme.

10. KSS Consented Scheme and Flyover

OPTION SUMMARY

- KSS scheme with vehicular traffic diverted over a flyover to increase pavement width at ground floor level



Assessment

CROWD SAFETY

It is assumed that one vehicle lane in each direction would remain, and that this would carry local traffic only. The relative density of vehicles on the flyover and at grade is not yet known.

The alignment of the remaining lanes would provide need to provide additional walkway width to the eastern side of the High Road, sufficient to provide capacity for spectators to move without the need to move into the road. If the two remaining vehicle lanes are aligned with the central lanes now but wider, then the additional width would be less than that provided by the road, suggesting that the alignment would need to be towards the western pavement.

Barriers (and supporting stewarding) would still be required to demarcate the pedestrian-vehicle boundary.

HIGHWAYS AND TRANSPORT

It would be very difficult to locate the up/down ramps to the north and south without extensive demolition of existing buildings. The flyover section would be very expensive to build and would disrupt existing utility services. It would take many years of highly disruptive construction to implement even with the simplest central support option.

The local traffic and bus services would remain at grade in a 2 lane carriageway which would need to be almost as wide as the existing 4-lane cross-section – particularly given the overhead structure.

DELIVERABILITY

This would change the nature of the street and would significantly affect the setting of the Conservation area and all the Heritage Assets in it. A flyover would fundamentally harm the townscape, changing the relationship with the road and the buildings flanking it. In addition the up and down ramps may require substantial further demolition of HAs, presumably on the West side of the High Road.

Leaving aside the technical issues involved, and the delay and uncertainty in securing the necessary consent, the cost of this option makes it unviable, and disproportionate to any benefits.

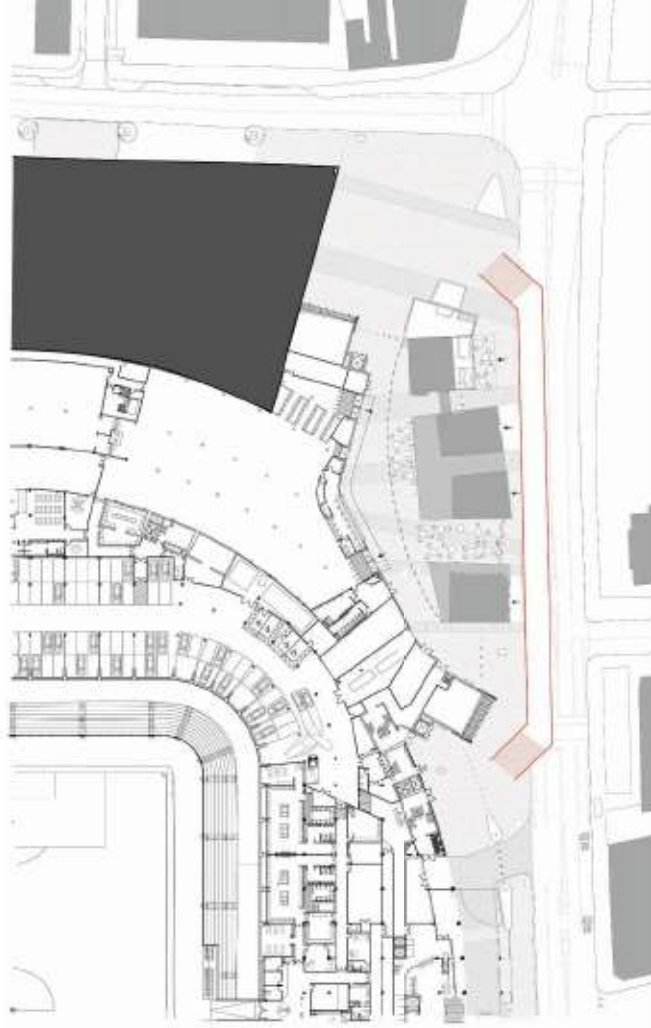
CONCLUSION

This option is considered undeliverable. In any event it is likely to have a significantly more harmful impact in heritage terms than the Populous Scheme.

11. KSS Consented Scheme and Pedestrian Bridge / Walkways

OPTION SUMMARY

- KSS scheme with new pedestrian walkway along eastern side of High Road that separates the pavement from vehicular traffic.



Assessment

CROWD SAFETY

This is worse than option 1.

People will be unwilling to go up and back down again to use an overpass (more so than using the canyon).

This would only be effective if it catered for the desire line in three dimensions. People would continue to use the narrow footpath unless it was blocked off completely.

The stairs/ramps to the raised walkway would reduce footpath width for other movements and would likely more people to walk into the roadway

If the footpath was blocked there would be a risk of people walking in the road without any escape from oncoming vehicles.

HIGHWAYS AND TRANSPORT

Assuming that any structural supports for the pedestrian bridges do not impact on the roadway, and that the roadway would be unchanged in this option from option 1, the analysis is therefore the same as option 1.

DELIVERABILITY

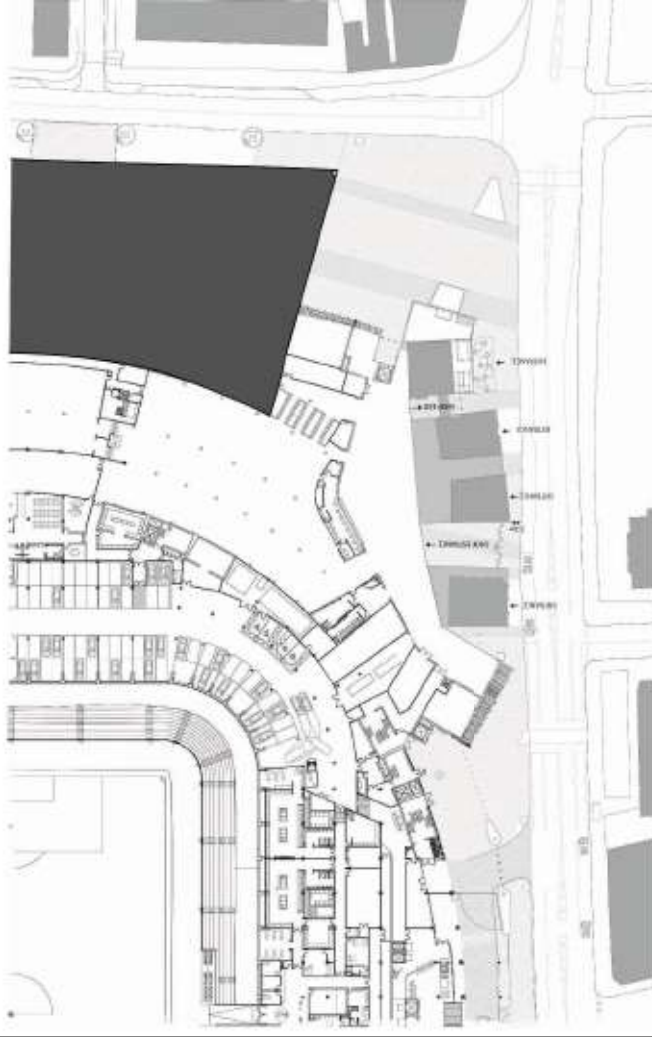
This would fundamentally change the nature of the street. The raised walkway would cause substantial harm to the Conservation Area and numerous heritage assets. Leaving aside the technical issues involved, and the delay and uncertainty in securing the necessary consents, the cost of this option makes it unviable, and disproportionate to any benefits.

	CONCLUSION This does not meet the objective of reducing the crowd safety risk to ALARP. Furthermore it is not considered deliverable and would cause substantial harm to the Conservation Area and numerous heritage assets.
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12. Consented Scheme with Extended Podium

OPTION SUMMARY

- A fundamental redesign of the Consented Scheme to close the canyon and bring the podium closer to the rear of the buildings



Assessment

CROWD SAFETY

People will be unwilling to go up and back down again to use the podium to circumnavigate 744-750 High Road (more so than using the canyon). This would only be effective if it catered for the desire line in three dimensions.

The overwhelming majority of people would continue to use the narrow footpath unless it was blocked off completely (in which case the same issues identified in respect of Option 2 would arise).

Thus the risk will be similar to, if not worse than option 1.

Entrances to 746 – 750 on the High Road would not be operationally viable. These would need to be closed on match day. As a result there would be no ground floor match day access

HIGHWAYS AND TRANSPORT

The southbound bus stop would need to be relocated further north perhaps to a point in front of the west side corporate spectator access or be removed without replacement.

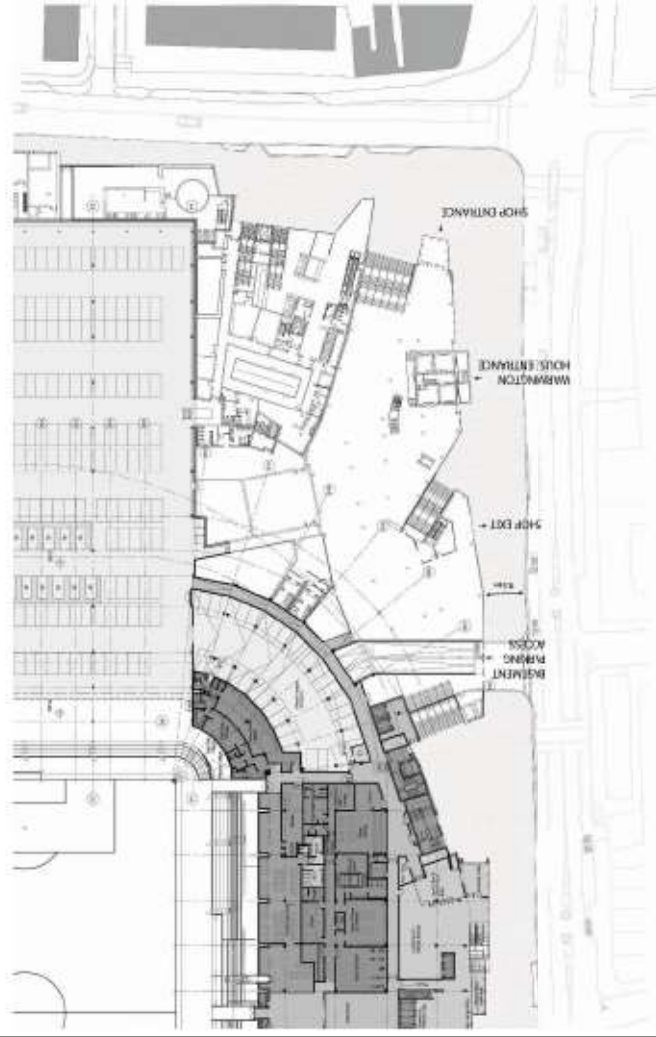
DELIVERABILITY

Without ground floor match day access to 746-750 high road any potential commercial viability would be compromised. As such, in addition to the significant crowd safety issues involved, this would not safeguard the future viability of the buildings.

CONCLUSION

This would not resolve the crowd safety risks associated with Option 1. It would not meet the objective of reducing the risk ALARP.

13. Populous Scheme



Assessment

CROWD SAFETY

This is demonstrably the safest option.

It provides space for crowd flow so that pedestrians can walk the way they want to without stepping off the footpath.

The walking area of the footpath will be protected by bollards. There is a space of 85cm between the kerb edge and this walking area. This acts as a buffer, so if people step outside of this walking area remain on the pavement.

The predicted flow of 185 people per minute through a width of 9.5m less 1.05m for bollards and edge effect gives a flow rate of 22 people/metre/minute LOS A. It provides a wide walkway allowing for manoeuvring away from the road.

Management measures, such as those discussed above, could be added as required, so this solution provides resilience.

HIGHWAYS AND TRANSPORT

The current Populous scheme is entirely consistent with the proposed stadium transport strategy. The proposed traffic management strategy makes the best use of the space available within the High Road to satisfy the possibly conflicting requirements of spectators, other pedestrians, bus operators and their passengers and stadium access by private vehicles, coaches/shuttle buses and the emergency services.

DELIVERABILITY

The Populous scheme is viable, subject to gap funding, and deliverable without delay, subject to planning.

The proposals would see the loss of three locally listed buildings, which is a 'planning risk'. However, in the absence of any viable alternative which retains them, and taking into account the overall planning balance (see Planning Statement) there is a sound justification for their loss.

In townscape terms this would be a great improvement over the other options and, indeed, in bringing life and interest to the High Road itself this would mean the conservation area would be invigorated and enlivened, resulting in major benefits. This option also provides a long term viable use for Warrington House

	CONCLUSION This option is the safest option, is deliverable, subject to planning, and is entirely consistent with the overall transport strategy.
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9.0 Concluding Summary

9.1 We set out the results of the option appraisal below, based on the three criteria of crowd safety, traffic and highways impact, and viability/deliverability.

Option Appraisal Summary	Crowd Safety	Highways	Deliverability
1. The Consented Scheme with no mitigation	✗	✓	✗
2. The Consented with barriers and stewarding	✗	✓	✗
3. The Consented Scheme with temporary closure of the Southbound bus lane	✗	✓	✗
4. The Consented Scheme with permanent closure of the Southbound bus lane	✗	✗	✗
5. Consented Scheme with Temporary Closure of Both Southbound Lanes	✗	✗	✗
6. The Consented Scheme with the temporary closure of both Southbound lanes and contraflow on the Northbound carriageway	✗	✗	✗
7. The Consented Scheme moving High Road westwards	✓	✗	✗
8. The Consented Scheme and shared surface on the High Road	✗	✗	✗
9. The Consented Scheme with a tunnel the High Road	✓	✗	✗
10. The Consented Scheme and Flyover above the High Road	✓	✗	✗
11. The Consented Scheme and pedestrian Bridge/walkways over the three buildings	✗	✗	✗
12. The Consented Scheme with an increased Podium	✗	✓	✗
13. The Populous Scheme	✓	✓	✓

- 9.2 This demonstrates that the only alternative options for retaining the locally listed buildings which are likely to address the requirements for crowd safety, and to reduce the risks to ALARP, are unacceptable in traffic and highways terms and incapable of being delivered. The cost, additional impacts and delays involved, and ultimately risk to the wider regeneration are disproportionate to any benefits they could deliver.
- 9.3 None of the less radical options offers an acceptable solution to the identified risks to crowd safety. In any event, in addition to the significant risks to public safety, the level of overcrowding in this identified pinch point would call into question the ability to secure viable commercial uses for the buildings, which in turn calls into question the viability of retaining the buildings in these scenarios.
- 9.4 The only option that is viable and deliverable, subject to planning, and meets the requirements for crowd safety and highways is the Populous Scheme, which necessitates the loss of these buildings. Taking the wider heritage and planning issues into account, including the significant heritage and wider regeneration benefits which are set out in the Planning Statement, there is clear justification for the loss of these buildings. Any localised heritage impact is more than offset by the wider heritage and other public benefits which the development delivers.

A6.2 Construction Dust Assessment Procedure

A6.2.1 The criteria developed by IAQM, upon which the GLA's guidance is based, divide the activities on construction sites into four types to reflect their different potential impacts. These are:

- demolition;
- earthworks;
- construction; and
- trackout.

A6.2.2 The assessment procedure includes the four steps summarised below:

STEP 1: Screen the Need for a Detailed Assessment

A6.2.3 An assessment is required where there is a human receptor within 350 m of the boundary of the site and/or within 50 m of the route(s) used by construction vehicles on the public highway, up to 500 m from the site entrance(s), or where there is an ecological receptor within 50 m of the boundary of the site and/or within 50 m of the route(s) used by construction vehicles on the public highway, up to 500 m from the site entrance(s).

A6.2.4 Where the need for a more detailed assessment is screened out, it can be concluded that the level of risk is *negligible* and that any effects will be 'not significant'. No mitigation measures beyond those required by legislation will be required.

STEP 2: Assess the Risk of Dust Impacts

A6.2.5 A site is allocated to a risk category based on two factors:

- the scale and nature of the works, which determines the potential dust emission magnitude (Step 2A); and
- the sensitivity of the area to dust effects (Step 2B).

A6.2.6 These two factors are combined in Step 2C, which is to determine the risk of dust impacts with no mitigation applied. The risk categories assigned to the site may be different for each of the four potential sources of dust (demolition, earthworks, construction and trackout).

Step 2A – Define the Potential Dust Emission Magnitude

A6.2.7 Dust emission magnitude is defined as either 'Small', 'Medium', or 'Large'. The IAQM explains that this classification should be based on professional judgement, but provides the examples in Table A6. **Error! No text of specified style in document..1.**

Table A6. **Error! No text of specified style in document..1: Examples of How the Dust Emission Magnitude Class May be Defined**

Class	Examples
Demolition	
Large	Total building volume >50,000 m ³ , potentially dusty construction material (e.g. concrete), on site crushing and screening, demolition activities >20 m above ground level
Medium	Total building volume 20,000 m ³ – 50,000 m ³ , potentially dusty construction material, demolition activities 10-20 m above ground level
Small	Total building volume <20,000 m ³ , construction material with low potential for dust release (e.g. metal cladding or timber), demolition activities <10 m above ground, demolition during wetter months
Earthworks	
Large	Total site area >10,000 m ² , potentially dusty soil type (e.g. clay, which will be prone to suspension when dry to due small particle size), >10 heavy earth moving vehicles active at any one time, formation of bunds >8 m in height, total material moved >100,000 tonnes
Medium	Total site area 2,500 m ² – 10,000 m ² , moderately dusty soil type (e.g. silt), 5-10 heavy earth moving vehicles active at any one time, formation of bunds 4 m – 8 m in height, total material moved 20,000 tonnes – 100,000 tonnes
Small	Total site area <2,500 m ² , soil type with large grain size (e.g. sand), <5 heavy earth moving vehicles active at any one time, formation of bunds <4 m in height, total material moved <10,000 tonnes, earthworks during wetter months
Construction	
Large	Total building volume >100,000 m ³ , piling, on site concrete batching; sandblasting
Medium	Total building volume 25,000 m ³ – 100,000 m ³ , potentially dusty construction material (e.g. concrete), piling, on site concrete batching
Small	Total building volume <25,000 m ³ , construction material with low potential for dust release (e.g. metal cladding or timber)
Trackout ^a	

Large	>50 HDV (>3.5t) outward movements in any one day, potentially dusty surface material (e.g. high clay content), unpaved road length >100 m
Medium	10-50 HDV (>3.5t) outward movements in any one day, moderately dusty surface material (e.g. high clay content), unpaved road length 50 m – 100 m
Small	<10 HDV (>3.5t) outward movements in any one day, surface material with low potential for dust release, unpaved road length <50 m

^a These numbers are for vehicles that leave the site after moving over unpaved ground.

Step 2B – Define the Sensitivity of the Area

A6.2.8 The sensitivity of the area is defined taking account of a number of factors:

- the specific sensitivities of receptors in the area;
- the proximity and number of those receptors;
- in the case of PM₁₀, the local background concentration; and
- site-specific factors, such as whether there are natural shelters to reduce the risk of wind-blown dust.

A6.2.9 The first requirement is to determine the specific sensitivities of local receptors. The IAQM recommends that this should be based on professional judgment, taking account of the principles in Table A6.2. These receptor sensitivities are then used in the matrices set out in Table A6.3, Table A6.4 and Table A6.5 to determine the sensitivity of the area. Finally, the sensitivity of the area is considered in relation to any other site-specific factors, such as the presence of natural shelters etc., and any required adjustments to the defined sensitivities are made.

Step 2C – Define the Risk of Impacts

A6.2.10 The dust emission magnitude determined at Step 2A is combined with the sensitivity of the area determined at Step 2B to determine the *risk* of impacts with no mitigation applied. The IAQM provides the matrix in Table A6.6 as a method of assigning the level of risk for each activity.

STEP 3: Determine Site-specific Mitigation Requirements

A6.2.11 The IAQM provides a suite of recommended and desirable mitigation measures which are organised according to whether the outcome of Step 2 indicates a low, medium, or high risk. The list provided by the IAQM has been used as the basis for the requirements set out in Appendix A6.9.

STEP 4: Determine Significant Effects

A6.2.12 The IAQM does not provide a method for assessing the significance of effects before mitigation, and advises that pre-mitigation significance should not be determined. With appropriate mitigation in place, the IAQM guidance is clear that the residual effect will normally not be significant (Institute of Air Quality Management, 2014).

A6.2.13 The IAQM guidance recognises that, even with a rigorous dust management plan in place, it is not possible to guarantee that the dust mitigation measures will be effective all of the time, for instance under adverse weather conditions. The local community may therefore experience occasional, short-term dust annoyance. The scale of this would not normally be considered sufficient to change the conclusion that the effects will be 'not significant'.

Table A6.Error! No text of specified style in document..2:
When Defining Receptor Sensitivities

Principles to be Used

Class	Principles	Examples
Sensitivities of People to Dust Soiling Effects		
High	users can reasonably expect enjoyment of a high level of amenity; or the appearance, aesthetics or value of their property would be diminished by soiling; and the people or property would reasonably be expected to be present continuously, or at least regularly for extended periods, as part of the normal pattern of use of the land	dwellings, museum and other culturally important collections, medium and long term car parks and car showrooms
Medium	users would expect to enjoy a reasonable level of amenity, but would not reasonably expect to enjoy the same level of amenity as in their home; or the appearance, aesthetics or value of their property could be diminished by soiling; or the people or property wouldn't reasonably be expected to be present here continuously or regularly for extended periods as part of the normal pattern of use of the land	parks and places of work
Low	the enjoyment of amenity would not reasonably be expected; or there is property that would not reasonably be expected to be diminished in appearance, aesthetics or value by soiling; or there is transient exposure, where the people or property would reasonably be expected to be present only for limited periods of time as part of the normal pattern of use of the land	playing fields, farmland (unless commercially-sensitive horticultural), footpaths, short term car parks and roads
Sensitivities of People to the Health Effects of PM₁₀		
High	locations where members of the public may be exposed for eight hours or more in a day	residential properties, hospitals, schools and residential care homes
Medium	locations where the people exposed are workers, and where individuals may be exposed for eight hours or more in a day.	may include office and shop workers, but will generally not include workers occupationally exposed to PM ₁₀
Low	locations where human exposure is transient	public footpaths, playing fields, parks and shopping streets
Sensitivities of Receptors to Ecological Effects		
High	locations with an international or national designation and the designated features may be affected by dust soiling; or locations where there is a community of a particularly dust sensitive species	Special Areas of Conservation with dust sensitive features

Class	Principles	Examples
Medium	locations where there is a particularly important plant species, where its dust sensitivity is uncertain or unknown; or locations with a national designation where the features may be affected by dust deposition	Sites of Special Scientific Interest with dust sensitive features
Low	locations with a local designation where the features may be affected by dust deposition	Local Nature Reserves with dust sensitive features

Table A6. Error! No text of specified style in document.:3: **Sensitivity of the Area to Effects on People and Property from Dust Soiling**¹

Receptor Sensitivity	Number of Receptors	Distance from the Source (m)			
		<20	<50	<100	<350
High	>100	High	High	Medium	Low
	10-100	High	Medium	Low	Low
	1-10	Medium	Low	Low	Low
Medium	>1	Low	Low	Low	Low
Low	>1	Low	Low	Low	Low

¹ For demolition, earthworks and construction, distances are taken either from the dust source or from the boundary of the site. For trackout, distances are measured from the sides of roads used by construction traffic. Without mitigation, trackout may occur from roads up to 500 m from large sites, 200 m from medium sites and 50 m from small sites, as measured from the site exit. The impact declines with distance from the site, and it is only necessary to consider trackout impacts up to 50 m from the edge of the road.

Table A6.Error! No text of specified style in document..4:
Human Health Effects¹

Sensitivity of the Area to

Receptor Sensitivity	Annual Mean PM ₁₀	Number of Receptors	Distance from the Source (m)				
			<20	<50	<100	<200	<350
High	>32 µg/m ³	>100	High	High	High	Medium	Low
		10-100	High	High	Medium	Low	Low
		1-10	High	Medium	Low	Low	Low
	28-32 µg/m ³	>100	High	High	Medium	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	High	Medium	Low	Low	Low
	24-28 µg/m ³	>100	High	Medium	Low	Low	Low
		10-100	High	Medium	Low	Low	Low
		1-10	Medium	Low	Low	Low	Low
	<24 µg/m ³	>100	Medium	Low	Low	Low	Low
		10-100	Low	Low	Low	Low	Low
		1-10	Low	Low	Low	Low	Low
Medium	-	>10	High	Medium	Low	Low	Low
	-	1-10	Medium	Low	Low	Low	Low
Low	-	>1	Low	Low	Low	Low	Low

Table A6.Error! No text of specified style in document..5:
Ecological Effects¹

Sensitivity of the Area to

Receptor Sensitivity	Distance from the Source (m)	
	<20	<50
High	High	Medium
Medium	Medium	Low
Low	Low	Low

Table A6.Error! No text of specified style in document..6:
Impacts
Defining the Risk of Dust

Sensitivity of the Area	Dust Emission Magnitude		
	Large	Medium	Small
Demolition			
High	High Risk	Medium Risk	Medium Risk
Medium	High Risk	Medium Risk	Low Risk
Low	Medium Risk	Low Risk	Negligible
Earthworks			
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Medium Risk	Low Risk
Low	Low Risk	Low Risk	Negligible
Construction			
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Medium Risk	Low Risk
Low	Low Risk	Low Risk	Negligible
Trackout			
High	High Risk	Medium Risk	Low Risk
Medium	Medium Risk	Low Risk	Negligible
Low	Low Risk	Low Risk	Negligible

A6.3 EPUK & IAQM Planning for Air Quality Guidance

A6.3.1 The guidance issued by EPUK and IAQM¹ (EPUK & IAQM, 2015) is comprehensive in its explanation of the place of air quality in the planning regime. Key sections of the guidance not already mentioned above are set out below.

Air quality as a material consideration

“Any air quality issue that relates to land use and its development is capable of being a material planning consideration. The weight, however, given to air quality in making a planning application decision, in addition to the policies in the local plan, will depend on such factors as:

- *the severity of the impacts on air quality;*
- *the air quality in the area surrounding the proposed development;*
- *the likely use of the development, i.e. the length of time people are likely to be exposed at that location; and*
- *the positive benefits provided through other material considerations”.*

Recommended Best Practice

A6.3.2 The guidance goes into detail on how all development proposals can and should adopt good design principles that reduce emissions and contribute to better air quality management. It states:

“The basic concept is that good practice to reduce emissions and exposure is incorporated into all developments at the outset, at a scale commensurate with the emissions”.

A6.3.3 The guidance sets out a number of good practice principles that should be applied to all developments that:

- include 10 or more dwellings;
- where the number of dwellings is not known, residential development is carried out on a site of more than 0.5 ha;
- provide more than 1,000 m² of commercial floorspace;
- are carried out on land of 1 ha or more.

¹ The IAQM is the professional body for air quality practitioners in the UK.

A6.3.4 The good practice principles are that:

- New developments should not contravene the Council's Air Quality Action Plan, or render any of the measures unworkable;
- Wherever possible, new developments should not create a new "street canyon", as this inhibits pollution dispersion;
- Delivering sustainable development should be the key theme of any application;
- New development should be designed to minimise public exposure to pollution sources, e.g. by locating habitable rooms away from busy roads;
- The provision of at least 1 Electric Vehicle (EV) "rapid charge" point per 10 residential dwellings and/or 1000 m² of commercial floorspace. Where on-site parking is provided for residential dwellings, EV charging points for each parking space should be made available;
- Where development generates significant additional traffic, provision of a detailed travel plan (with provision to measure its implementation and effect) which sets out measures to encourage sustainable means of transport (public, cycling and walking) via subsidised or free-ticketing, improved links to bus stops, improved infrastructure and layouts to improve accessibility and safety;
- All gas-fired boilers to meet a minimum standard of <40 mgNO_x/kWh;
- Where emissions are likely to impact on an AQMA, all gas-fired CHP plant to meet a minimum emissions standard of:
 - Spark ignition engine: 250 mgNO_x/Nm³;
 - Compression ignition engine: 400 mgNO_x/Nm³;
 - Gas turbine: 50 mgNO_x/Nm³.
- A presumption should be to use natural gas-fired installations. Where biomass is proposed within an urban area it is to meet minimum emissions standards of 275 mgNO_x/Nm³ and 25 mgPM/Nm³.

A6.3.5 The guidance also outlines that offsetting emissions might be used as a mitigation measure for a proposed development. However, it states that:

"It is important that obligations to include offsetting are proportional to the nature and scale of development proposed and the level of concern about air quality; such offsetting can be based on a quantification of the emissions associated with the development. These emissions can be assigned a value, based on the "damage cost approach" used by Defra, and then applied as an indicator of the level of offsetting required, or as a financial obligation on the developer. Unless some form of benchmarking is applied, it is impractical to include

building emissions in this approach, but if the boiler and CHP emissions are consistent with the standards as described above then this is not essential".

A6.3.6 The guidance offers a widely used approach for quantifying costs associated with pollutant emissions from transport. It also outlines the following typical measures that may be considered to offset emissions, stating that measures to offset emissions may also be applied as post assessment mitigation:

- Support and promotion of car clubs;
- Contributions to low emission vehicle refuelling infrastructure;
- Provision of incentives for the uptake of low emission vehicles;
- Financial support to low emission public transport options; and
- Improvements to cycling and walking infrastructures.

Screening

Impacts of the Local Area on the Development

"There may be a requirement to carry out an air quality assessment for the impacts of the local area's emissions on the proposed development itself, to assess the exposure that residents or users might experience. This will need to be a matter of judgement and should take into account:

- *the background and future baseline air quality and whether this will be likely to approach or exceed the values set by air quality objectives;*
- *the presence and location of Air Quality Management Areas as an indicator of local hotspots where the air quality objectives may be exceeded;*
- *the presence of a heavily trafficked road, with emissions that could give rise to sufficiently high concentrations of pollutants (in particular nitrogen dioxide), that would cause unacceptably high exposure for users of the new development; and*
- *the presence of a source of odour and/or dust that may affect amenity for future occupants of the development".*

Impacts of the Development on the Local Area

A6.3.7 The guidance sets out two stages of screening criteria that can be used to identify whether a detailed air quality assessment is required, in terms of the impact of the development on the local area. The first stage is that you should proceed to the second stage if any of the follow apply:

- 10 or more residential units or a site area of more than 0.5 ha residential use;
- more than 1,000 m² of floor space for all other uses or a site area greater than 1 ha.

A6.3.8 Coupled with any of the following:

- the development has more than 10 parking spaces;
- the development will have a centralised energy facility or other centralised combustion process.

A6.3.9 If the above do not apply then the development can be screened out as not requiring a detailed air quality assessment of the impact of the development on the local area. If they do apply then you proceed to stage 2, the criteria for which are set out below. The criteria are more stringent where the traffic impacts may arise on roads where concentrations are close to the objective. The presence of an AQMA is taken to indicate the possibility of being close to the objective, but where whole authority AQMAs are present and it is known that the affected roads have concentrations below 90% of the objective, the less stringent criteria is likely to be more appropriate.

- the development will lead to a change in LDV flows of more than 100 AADT within or adjacent to an AQMA or more than 500 AADT elsewhere;
- the development will lead to a change in HDV flows of more than 25 AADT within or adjacent to an AQMA or more than 100 AADT elsewhere;
- the development will lead to a realigning of roads (i.e. changing the proximity of receptors to traffic lanes) where the change is 5m or more and the road is within an AQMA;
- the development will introduce a new junction or remove an existing junction near to relevant receptors, and the junction will cause traffic to significantly change vehicle acceleration/deceleration, e.g. traffic lights, or roundabouts;
- the development will introduce or change a bus station where bus flows will change by more than 25 AADT within or adjacent to an AQMA or more than 100 AADT elsewhere;
- the development will have an underground car park with more than 100 movements per day (total in and out) with an extraction system that exhausts within 20 m of a relevant receptor;
- the development will have one or more substantial combustion processes where the combustion unit is:
 - any centralised plant using bio fuel;
 - any combustion plant with single or combined thermal input >300 kW; or

- a standby emergency generator associated with a centralised energy centre (if likely to be tested/used >18 hours a year).
- the development will have a combustion unit of any size where emissions are at a height that may give rise to impacts through insufficient dispersion, e.g. through nearby buildings.

A6.3.10 Should none of the above apply then the development can be screened out as not requiring a detailed air quality assessment of the impact of the development on the local area.

A6.3.11 The guidance also outlines what the content of the air quality assessment should include, and this has been adhered to in the production of this report.

Impact Descriptors and Assessment of Significance

A6.3.12 There is no official guidance in the UK on how to describe the nature of air quality impacts, nor how to assess their significance. The approach developed by EPUK and IAQM² (EPUK & IAQM, 2015) has therefore been used. This approach involves a two stage process:

- a qualitative or quantitative description of the impacts on local air quality arising from the development; and
- a judgement on the overall significance of the effects of any impacts.

Impact Descriptors

A6.3.13 Impact description involves expressing the magnitude of incremental change as a proportion of a relevant assessment level and then examining this change in the context of the new total concentration and its relationship with the assessment criterion. Table A6.3.1 sets out the method for determining the impact descriptor for annual mean concentrations at individual receptors, having been adapted from the table presented in the guidance document. For the assessment criterion the term Air Quality Assessment Level or AQAL has been adopted, as it covers all pollutants, i.e. those with and without formal standards. Typically, as is the case for this assessment, the AQAL will be the air quality objective value. Note that impacts may be adverse or beneficial, depending on whether the change in concentration is positive or negative.

² The IAQM is the professional body for air quality practitioners in the UK.

Table A6.3.1: Air Quality Impact Descriptors for Individual Receptors for All Pollutants ^a

Long-Term Average Concentration At Receptor In Assessment Year ^b	Change in concentration relative to AQAL ^c				
	0%	1%	2-5%	6-10%	>10%
75% or less of AQAL	Negligible	Negligible	Negligible	Slight	Moderate
76-94% of AQAL	Negligible	Negligible	Slight	Moderate	Moderate
95-102% of AQAL	Negligible	Slight	Moderate	Moderate	Substantial
103-109% of AQAL	Negligible	Moderate	Moderate	Substantial	Substantial
110% or more of AQAL	Negligible	Moderate	Substantial	Substantial	Substantial

^a Values are rounded to the nearest whole number.

^b This is the 'without scheme' concentration where there is a decrease in pollutant concentration and the 'with scheme' concentration where there is an increase.

^c AQAL = Air Quality Assessment Level, which may be an air quality objective, EU limit or target value, or an Environment Agency 'Environmental Assessment Level (EAL)'.

Assessment of Significance

A6.3.14 The IAQM guidance (EPUK & IAQM, 2015) is that the assessment of significance should be based on professional judgement, with the overall air quality impact of the scheme described as either significant or not significant. In drawing this conclusion, the following factors should be taken into account:

- the existing and future air quality in the absence of the development;
- the extent of current and future population exposure to the impacts;
- the influence and validity of any assumptions adopted when undertaking the prediction of impacts;
- the potential for cumulative impacts and, in such circumstances, several impacts that are described as 'slight' individually could, taken together, be regarded as having a significant effect for the purposes of air quality management in an area, especially where it is proving difficult to reduce concentrations of a pollutant. Conversely, a 'moderate' or 'substantial' impact may not have a significant effect if it is confined to a very small area and where it is not obviously the cause of harm to human health; and
- the judgement on significance relates to the consequences of the impacts; will they have an effect on human health that could be considered as significant? In the majority of cases, the impacts from an individual development will be insufficiently large to result in measurable changes in health outcomes that could be regarded as significant by health care professionals.

A6.3.15 The guidance is clear that other factors may be relevant in individual cases. It also states that the effect on the residents of any new development where the air quality is such that an air quality objective is not met will be judged as significant. For people working at new developments in this situation, the same will not be true as occupational exposure standards are different, although any assessment may wish to draw attention to the undesirability of the exposure.

A6.3.16 A judgement of the significance should be made by a competent professional who is suitably qualified. A summary of the professional experience of the staff contributing to this assessment is provided in Appendix A6.4.

A6.4 Professional Experience

Prof. Duncan Laxen, BSc (Hons) MSc PhD MEnvSc FIAQM

Prof Laxen is the Managing Director of Air Quality Consultants, a company which he founded in 1993. He has over forty years' experience in environmental sciences and has been a member of Defra's Air Quality Expert Group and the Department of Health's Committee on the Medical Effects of Air Pollution. He has been involved in major studies of air quality, including nitrogen dioxide, lead, dust, acid rain, PM₁₀, PM_{2.5} and ozone and was responsible for setting up the UK's urban air quality monitoring network. Prof Laxen has been responsible for appraisals of all local authorities' air quality Review & Assessment reports and for providing guidance and support to local authorities carrying out their local air quality management duties. He has carried out air quality assessments for power stations; road schemes; ports; airports; railways; mineral and landfill sites; and residential/commercial developments. He has also been involved in numerous investigations into industrial emissions; ambient air quality; indoor air quality; nuisance dust and transport emissions. Prof Laxen has prepared specialist reviews on air quality topics and contributed to the development of air quality management in the UK. He has been an expert witness at numerous Public Inquiries, published over 70 scientific papers and given numerous presentations at conferences. He is a Fellow of the Institute of Air Quality Management.

Dr Ben Marner, BSc (Hons) PhD CSci MEnvSc MIAQM

Dr Marner is a Technical Director with AQC, and has over fifteen years' experience in the field of air quality. He has been responsible for air quality and greenhouse gas assessments of road schemes, rail schemes, airports, power stations, waste incinerators, commercial developments and residential developments in the UK and abroad. He has been an expert witness at several public inquiries, where he has presented evidence on health-related air quality impacts, the impacts of air quality on sensitive ecosystems, and greenhouse gas impacts. He has extensive experience of using detailed dispersion models, as well as contributing to the development of modelling best practices. Dr Marner has arranged and overseen air quality monitoring surveys, as well as contributing to Defra guidance on harmonising monitoring methods. He has been responsible for air quality review and assessments on behalf of numerous local authorities. He has also developed methods to predict nitrogen deposition fluxes on behalf of the Environment Agency, provided support and advice to the UK Government's air quality review and assessment helpdesk, Transport Scotland, Transport for London, and numerous local authorities. He is a Member of the Institute of Air Quality Management and a Chartered Scientist.

Laurence Caird, MEarthSci CSci MEnvSc MIAQM

Mr Caird is a Principal Consultant with AQC, with nine years' experience in the field of air quality including the detailed assessment of emissions from road traffic, airports, heating and energy plant, and a wide range of industrial sources including the thermal treatment of waste. He has experience in ambient air quality monitoring for numerous pollutants using a wide range of techniques and is also competent in the monitoring and assessment of nuisance odours and dust. Mr Caird has worked with a variety of clients to provide expert air quality services and advice, including local authorities, planners, developers and process operators. He is a Member of the Institute of Air Quality Management and is a Chartered Scientist.

Kieran Laxen, MEng (Hons) AMEnvSc MIAQM

Mr Laxen is a Senior Consultant with AQC with over six years' experience in the field of air quality management and assessment. Previously having two years' experience in scientific research on internal combustion engines, he now works in the field of air quality. He is involved in a wide range of development projects, most of which have involved use of ADMS modelling methodologies for biomass boilers, CHP plant and roads, and is also competent in the assessment of construction dust. He has pioneered the use of OpenAir software within the Company, which is used to analyse air quality monitoring data, and is responsible for routine calibration of air quality monitoring stations, together with data ratification. He is a Member of the Institute of Air Quality Management.

Caroline Odbert, BA (Hons) MSc MEnvSc MIAQM

Ms Odbert is a Senior Consultant with AQC with over nine years' relevant experience. She is involved in the preparation of air quality assessments for a range of development projects. She has been responsible for a wide range of air quality projects covering impact assessments for new residential and commercial developments, local air quality management, ambient air quality monitoring of nitrogen dioxide and sulphur dioxide and the assessment of nuisance odours. She has extensive modeling experience for road traffic and has worked with a variety of clients to provide expert air quality services and advice, including local authorities, planners, developers and process operators. She is a Member of the Institute of Air Quality Management.

Dr Austin Cogan, MPhys (Hons) PhD AMEnvSc AMIAQM

Dr Cogan is a Consultant with AQC and has over three years' experience in the fields of air quality modelling, monitoring and assessment. Prior to this he studied at the University of Leicester, gaining 2 years' experience of scientific instrument design and spent 4 years' pioneering research in satellite observations of carbon dioxide, including data validation,

model comparisons, bias correction and software development. He now works in the field of air quality assessment and has been involved in air quality, odour and climate change assessments of residential and commercial developments, road schemes, airports, waste management processes, and industrial processes. Dr Cogan has also been involved in the analysis and interpretation of air quality data and the preparation of review and assessment reports for local authorities.

Ricky Gellatly, BSc (Hons) AMIEnvSc AMIAQM

Mr Gellatly is a Senior Consultant with AQC with over four years' relevant experience. Prior to joining AQC he worked as an air quality consultant at Odournet UK Ltd. He has also worked as an oceanographer, and holds a first class degree in meteorology and oceanography from the University of East Anglia. He has undertaken air quality assessments for a wide range of projects, assessing many different pollution sources using both qualitative and quantitative methodologies, with most assessments having included dispersion modelling (using a variety of models). He has assessed road schemes, energy from waste facilities, anaerobic digesters, poultry farms, urban extensions, rail freight interchanges, energy centres, waste handling sites, sewage works and shopping and sports centres, amongst others. He also has experience in ambient air quality monitoring, the analysis and interpretation of air quality monitoring data, monitoring and assessment of nuisance odours and the monitoring and assessment of construction dust.

Dr Imogen Heard, BSc (Hons) MSc PhD MInstPhys

Dr Heard is a Consultant with AQC, having joined the company in 2013. Prior to joining she worked as a scientist in the Atmospheric Dispersion and Air Quality area at the UK Met Office for four years, modeling the dispersion of a range of pollutants over varying spatial and temporal scales. She now works in the field of air quality assessment and is involved in a range of development projects that include using ADMS dispersion models to study nitrogen dioxide, PM₁₀ and PM_{2.5} impacts, and the preparation of air quality assessment reports.

Full CVs are available at www.aqconsultants.co.uk.

A6.5 Figures

A6.8.1 The follow show the chapter figures.

Figure 6.1: Off-site Receptors for Air Quality Assessment

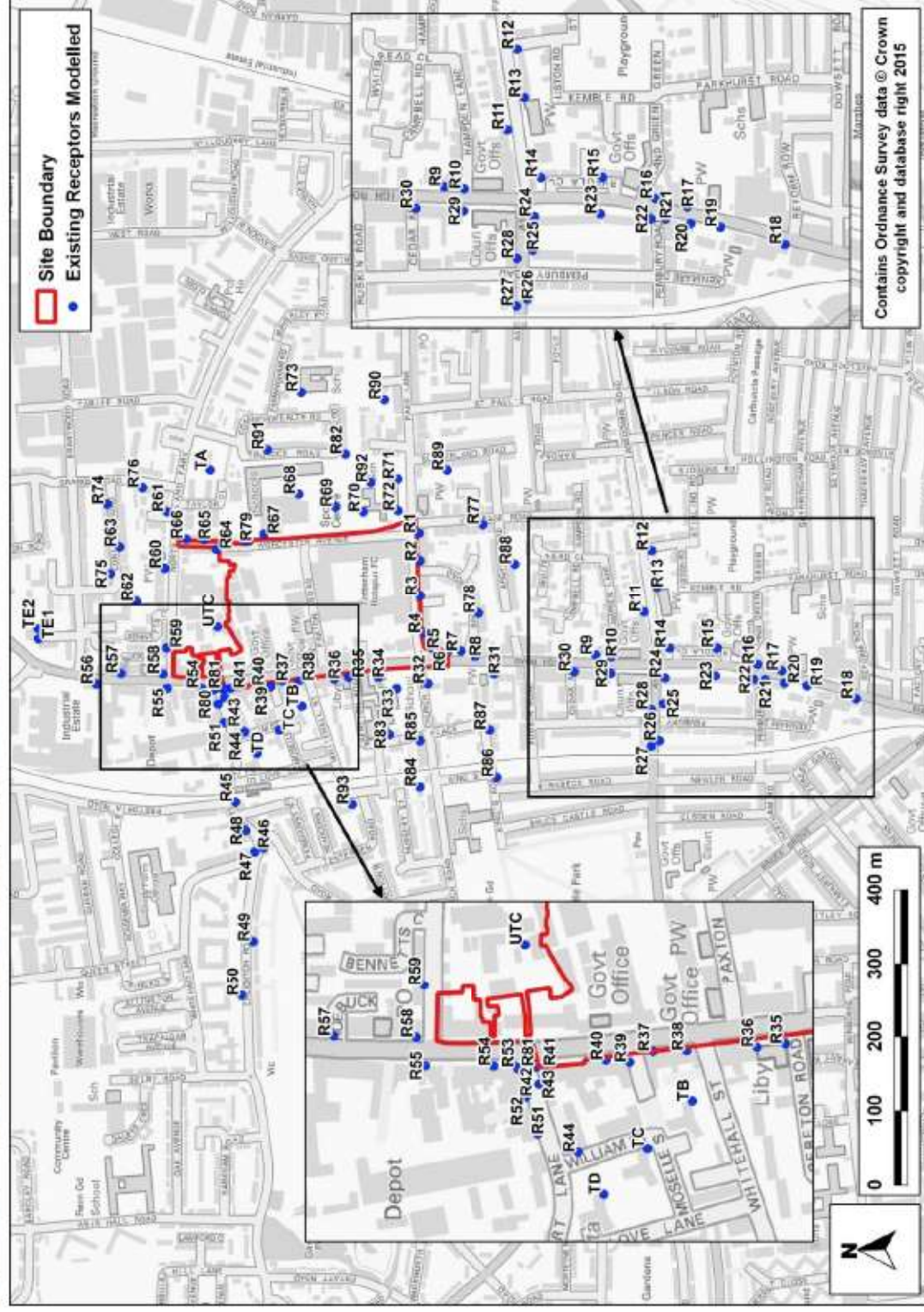


Figure 6.2: On-site Receptors for Air Quality Assessment

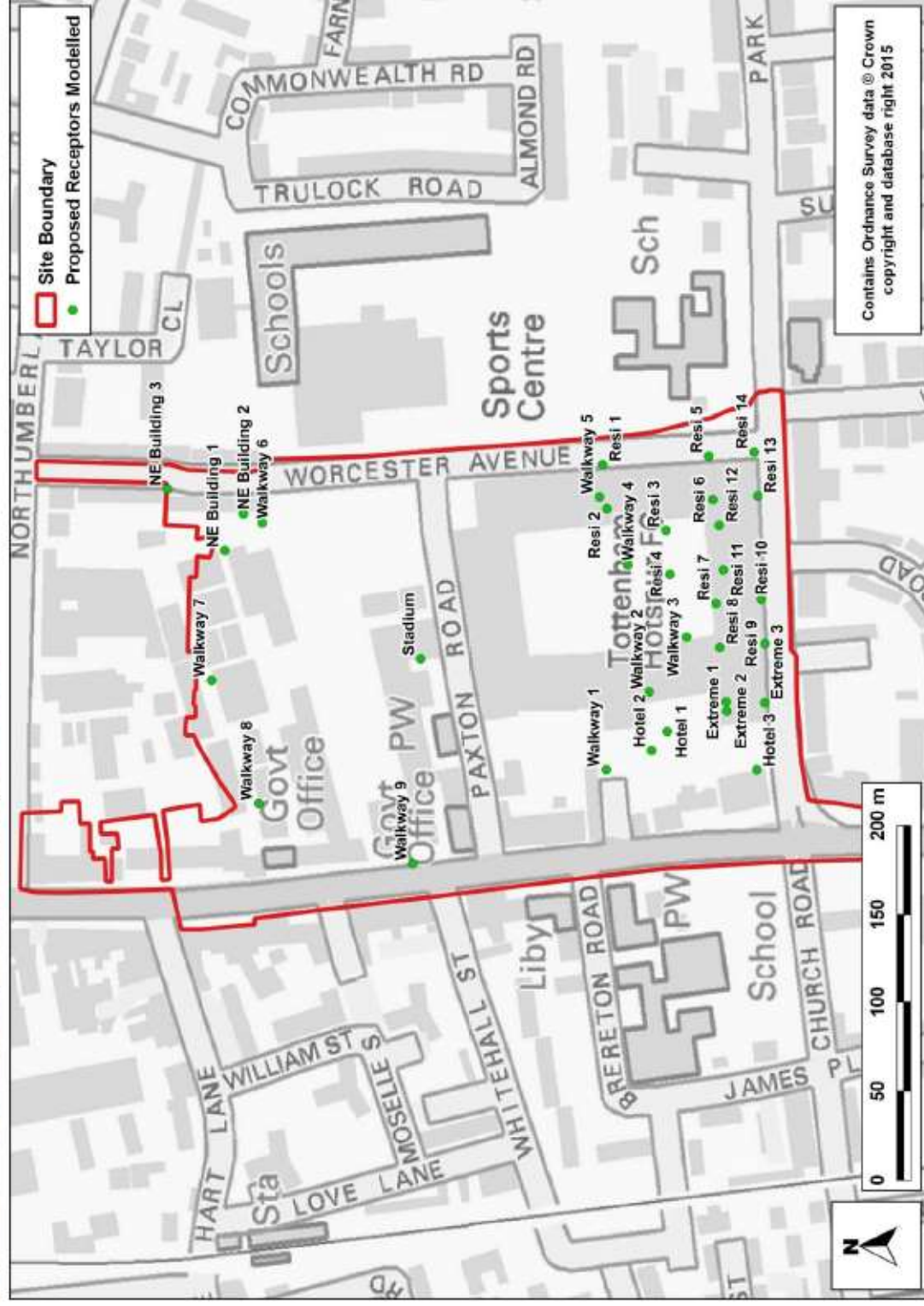


Figure 6.3: Harigeny Council Monitoring Sites

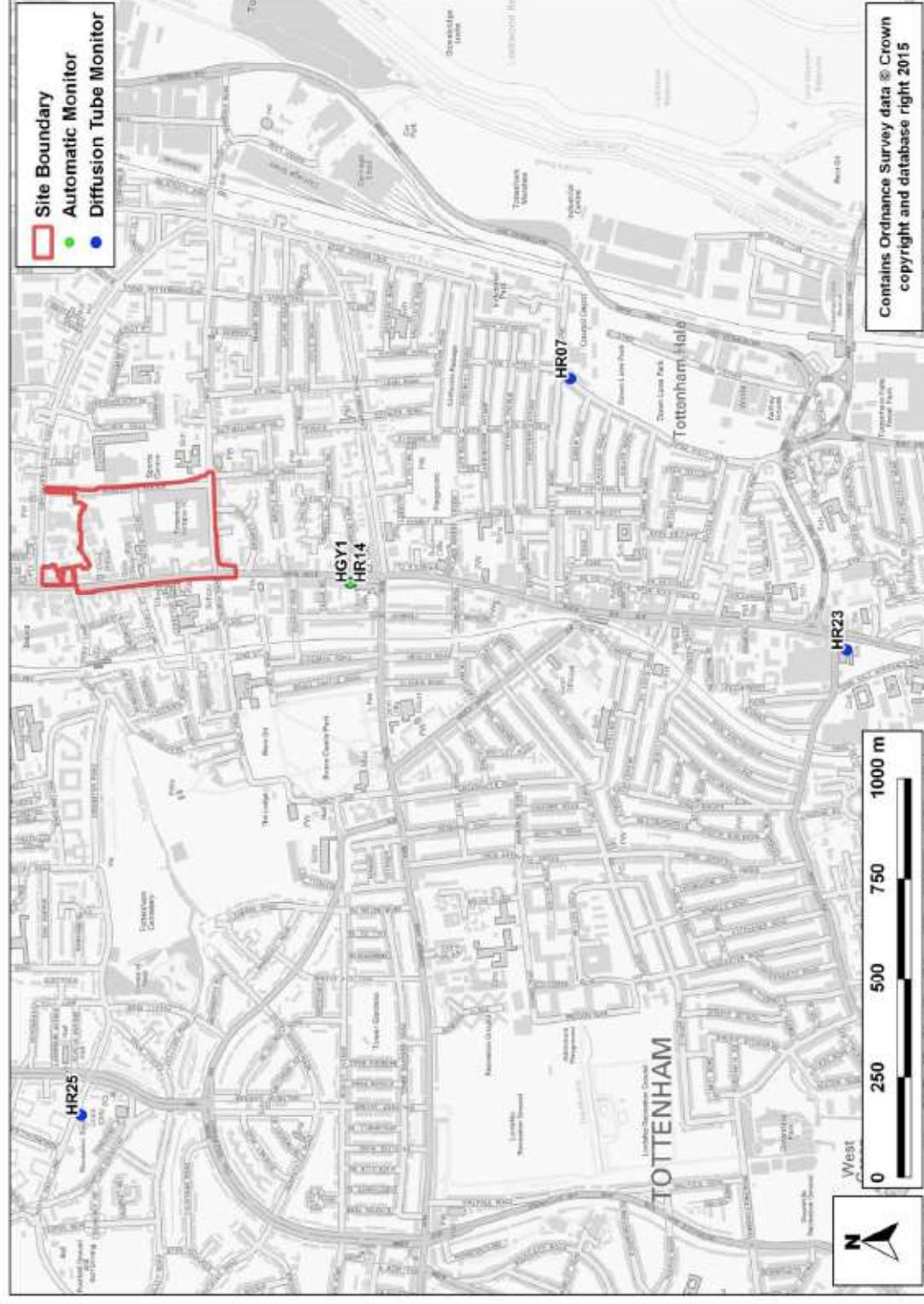


Figure 6.4: Haringey Town Hall Automatic Monitoring Nitrogen Dioxide Monthly Data Trend 2005-2014.

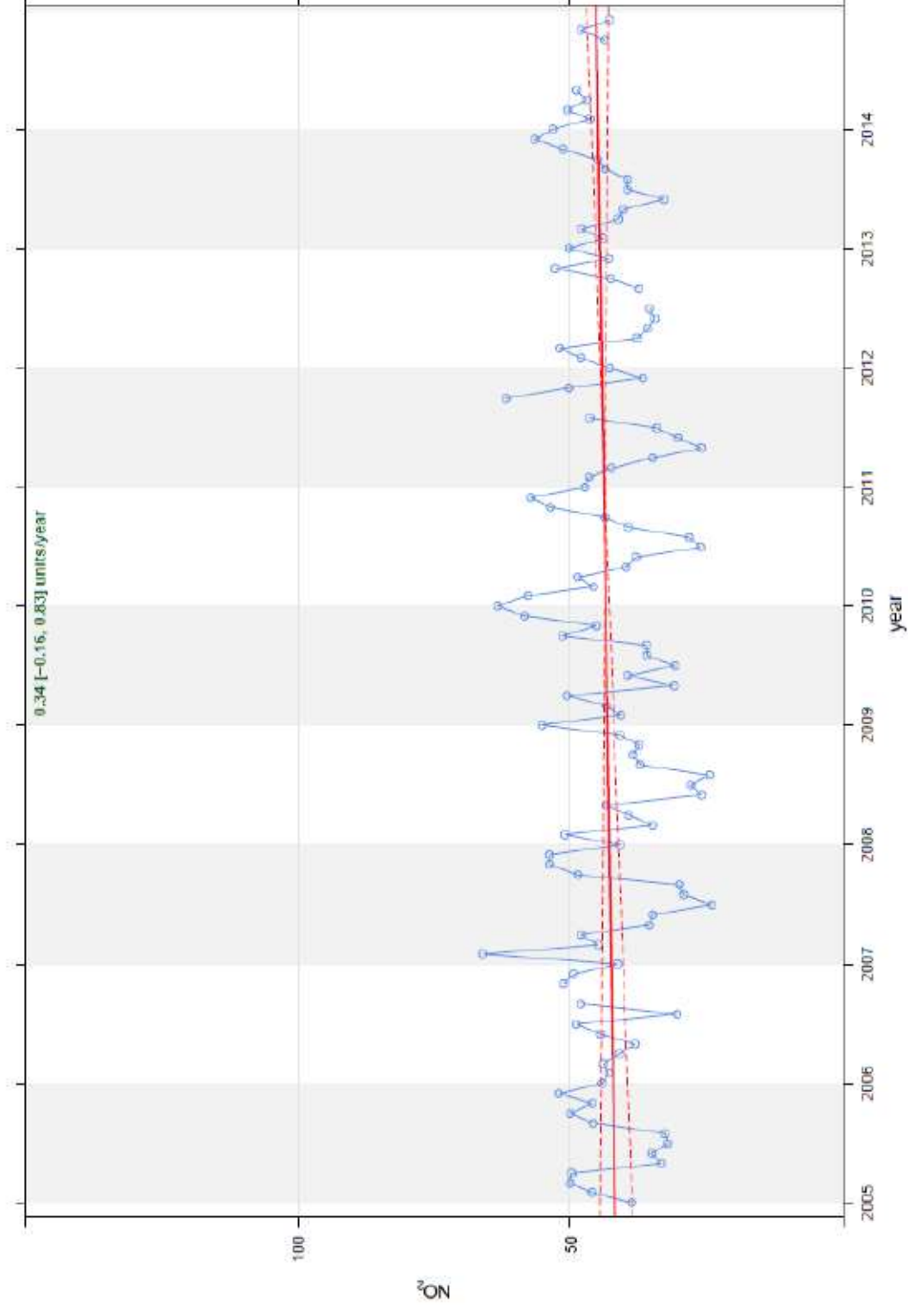


Figure 6.5: Construcion Site Buffer

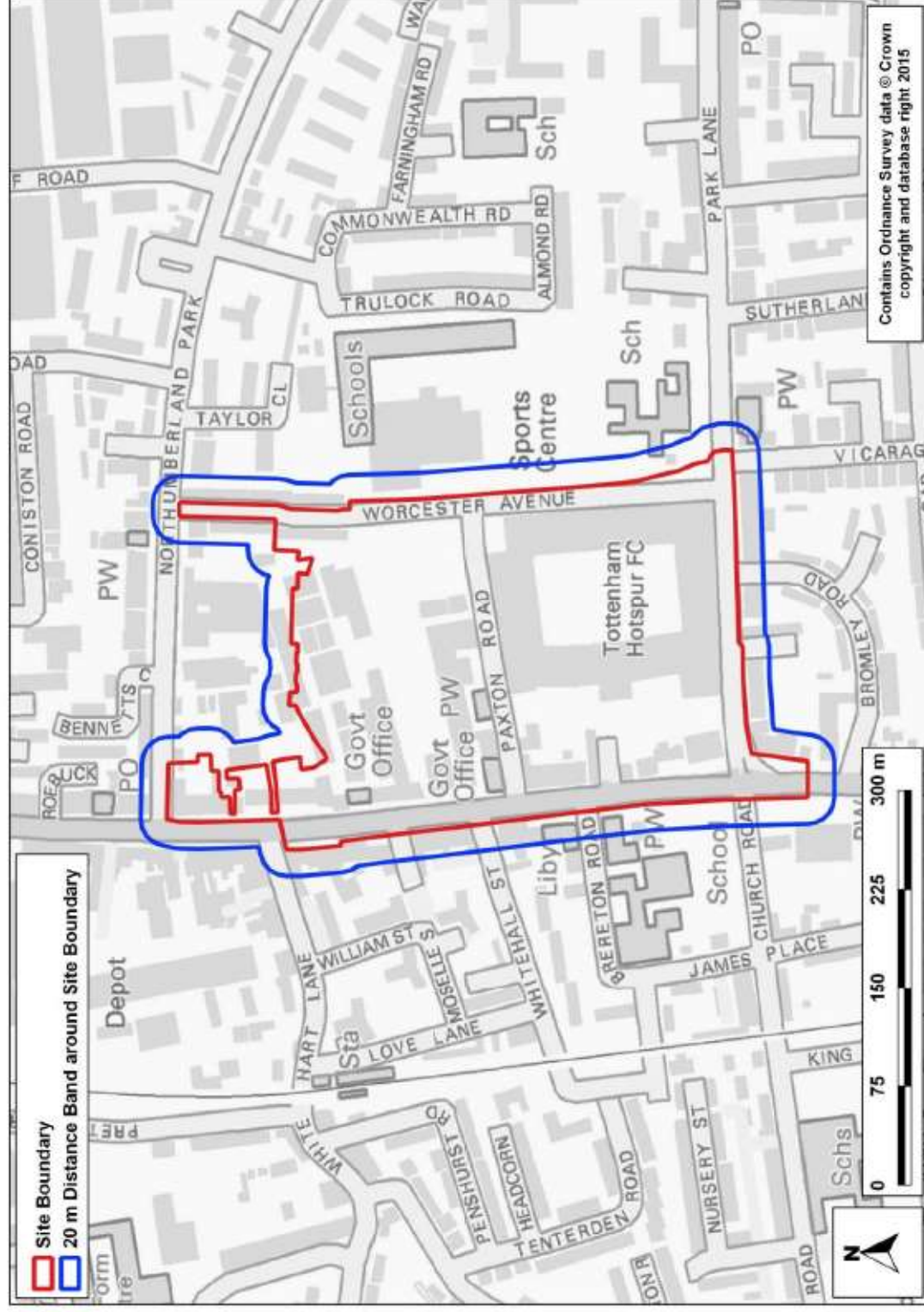
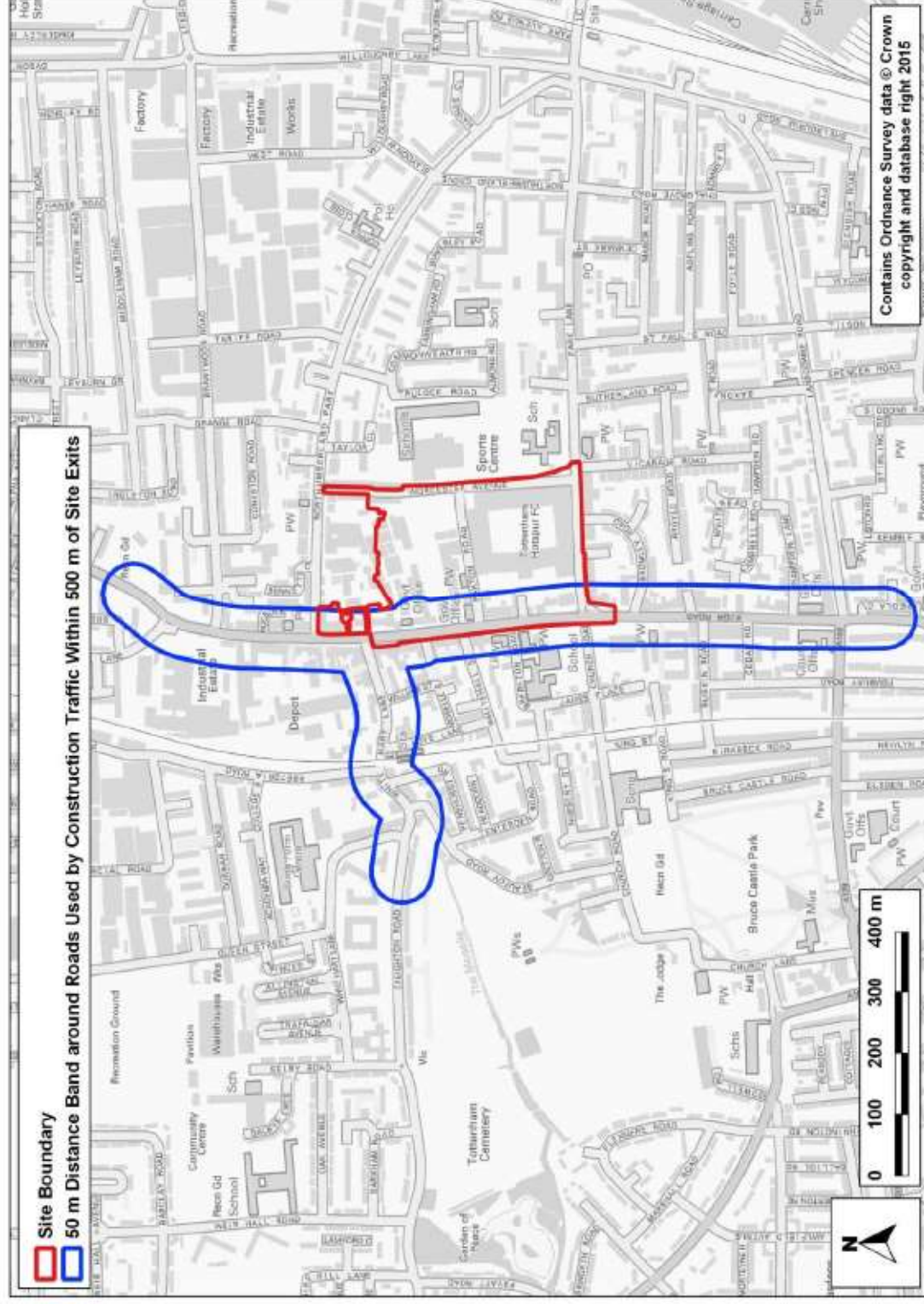


Figure 6.6: Construction Trackout Buffer



A6.6 Modelling Methodology

Background Concentrations

- A6.6.1 The background concentrations across the study area have been defined using the national pollution maps published by Defra (2015b). These cover the whole country on a 1x1 km grid and are published for each year from 2011 until 2030. The maps include the influence of emissions from a range of different sources; one of which is road traffic. As noted in Chapter 6, there is evidence that the current 'official' emissions factors published by Defra may over-predicted the rate at which road traffic emissions of nitrogen oxides will fall in the future. The maps currently in use were verified against measurements made during 2011 at a large number of automatic monitoring stations and so there can be reasonable confidence that the maps are representative of conditions during 2011. Similarly, there is reasonable confidence that the reductions which Defra predicts from other sectors (e.g. rail) will be achieved.
- A6.6.2 In order to calculate background nitrogen dioxide and nitrogen oxides concentrations in 2014, it is assumed that there was no reduction in the road traffic component of backgrounds between 2011¹ and 2014. This has been done using the source-specific background nitrogen oxides maps provided by Defra (2015b). For each grid square, the road traffic component has been held constant at 2011 levels, while 2014 values have been taken for the other components. Nitrogen dioxide concentrations have then been calculated using the background nitrogen dioxide calculator which Defra (2015b) publishes to accompany the maps. The result is a set of 'adjusted 2014 background' concentrations.
- A6.6.3 As an additional step, the 'adjusted 2014 background' mapped nitrogen dioxide values have been plotted against national background measurements made as part of the AURN (Defra, 2015d) during 2014 (see Figure A6.6.1). Based on the 40 sites with more than 75% data capture for 2014, the maps show an almost 1:1 relationship, being just 0.2% different. Thus no further adjustment has been applied to the 'adjusted' 2014 background concentrations and 2016, 2018 and 2021 background concentrations. The backgrounds have been derived for each 1x1 km grid point across the study area and then interpolated to each receptor location for use within the modelling.

¹ This approach assumes that there has been no reduction in emissions per vehicle, but that traffic volumes have remained constant. This is not the same as the assumption made for dispersion modelling, in which emissions per vehicle are held constant while traffic volumes are assumed to change year on year. This discrepancy is unlikely to influence the overall conclusions of the assessment.

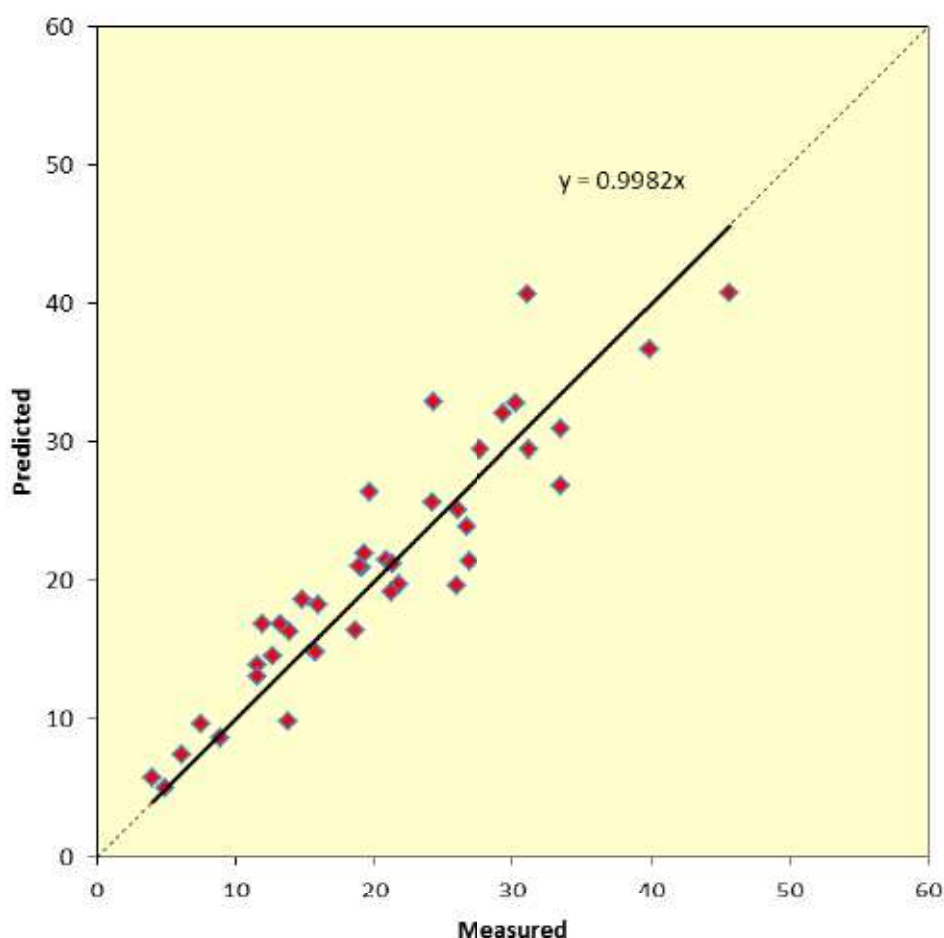


Figure A6.6.1: Predicted Mapped versus Measured NO₂ Concentrations at AURN Background Sites in 2014

- A6.6.4 Two separate sets of 2016, 2018 and 2021 background nitrogen dioxide concentrations have been used for the future-year assessment. The 2016, 2018 and 2021 background 'without emissions reduction' has been calculated using the same approach as described for the 2014 data: the road traffic component of background nitrogen oxides has been held constant at 2011 values, while 2016, 2018 and 2021 values for the other components are used as set out in the background maps. Nitrogen dioxide has then been calculated using Defra's background nitrogen dioxide calculator. The 2016, 2018 and 2021 background 'with emissions reduction' assumes that Defra's revised predicted reductions occur from 2014 onward. This dataset has been derived first by calculating the ratio of the unadjusted mapped value for 2016, 2018 and 2021 to the unadjusted mapped value for 2014. This ratio has then been applied to the adjusted 2014 value (as derived in Paragraph A6.6.2).
- A6.6.5 For PM₁₀ and PM_{2.5}, there is no strong evidence that Defra's predictions are unrealistic and so the year-specific mapped concentrations have been used in this assessment.

Model Inputs

Road Traffic

- A6.6.6 Predictions have been carried out using the ADMS-Roads dispersion model (v3.4). The model requires the user to provide various input data, including emissions from each section of road, and the road characteristics (including road width and street canyon height, where applicable). Vehicle emissions have been calculated based on vehicle flow, composition and speed data using the Emission Factor Toolkit (Version 6.0.2) published by Defra (2015b). For nitrogen dioxide, future-year concentrations have been predicted once using year-specific emission factors from the EFT, and once using emission factors for 2014², which is the year for which the model has been verified.
- A6.6.7 The model has been run using the full year of meteorological data that corresponds to the most recent set of nitrogen dioxide monitoring data (2014). The meteorological data has been taken from the monitoring station located at Northolt, which is considered suitable for this area.
- A6.6.8 For the purposes of modelling, it has been assumed that certain roads surrounding the development will have street canyon like features, meaning that the model assumes that only limited dispersion occurs within these areas. The roads that have been assumed to be street canyons are shown in Figure A6.5.2. These roads have a number of canyon-like features, which reduce dispersion of traffic emissions, and can therefore lead to concentrations of pollutants being higher here than they would be in areas with greater dispersion. They are not, however, all full canyons, as there are gaps between buildings allowing a reasonable level of near-road dispersion. ADMS-roads may therefore have over predicted concentrations at the façade of the properties adjacent to those streets assumed to be street canyons.
- A6.6.9 AADT flows, diurnal flow profiles, speeds, and vehicle fleet composition data have been provided by *Tim Spencer and Co* who prepared the Transport Assessment. Traffic data have been provided for all the scenarios. Baseline traffic data have been derived from 24hr counts at 20 locations within the local area in 2015. These traffic counts were taken on a non-event day and therefore do not include the contribution to the annual average daily flows of the event-day traffic. The one day traffic counts have been adjusted to represent annual average daily traffic (AADT) flows using DfT adjustment factors for typical urban areas, taking account of the time of year the counts were carried out.
- A6.6.10 An event-day cordon analysis has been carried out by Tim Spencer and Co. This analysis compared the number of trips that arrived/departed an area of within approximately 1 km of the development per year. This has been based on the number of trips per event multiplied

² i.e. combining current-year emission factors with future-year traffic data.

by the frequency of events. This annual trip generation has been compared with the total number of trips predicted on the main local roads for non-event days within 1 km of development (39,154,158 trips) to calculate the ratio of event related traffic to non-event related traffic as an annual factor. Based on 30 events this factor is 1.066 assuming a trip rate per event of 8,550 ($30 \times 8,550 / 39,154,158$). This is assumed to be the existing situation given 30 events per year. The proposed development is predicted to attract fewer trips per event of 6,019, however, the frequency of events is greater at 46 per year, and thus an event day factor of 1.071 has been calculated ($46 \times 6,019 / 39,154,158$).

A6.6.11 The uplift factor of 1.066 has been applied to the baseline 2015 traffic flows. The resultant baseline traffic data set represents AADT flows including the stadium related event-day traffic.

A6.6.12 Tim Spencer and Co have identified that traffic flows on local roads have been fairly constant over recent years, and if anything reducing. Therefore as a worst-case this 2015 baseline traffic dataset has been taken to represent both 2014 and future year baseline traffic data.

A6.6.13 The 2018 "with development" traffic datasets include the traffic generated by the aspects of the development operational in 2018 (36.7% of the full development traffic) and also a contribution to the annual average daily traffic flow of the additional event-day traffic (an uplift factor of 1.071 has been applied to the 2015 baseline traffic rather than 1.066 to account for this). The additional event-day traffic is based on an assumed number of events of 30 THFC matches, 10 NFL games and 6 concerts.

A6.6.14 The 2021 "with development" traffic datasets include the traffic generated by the entire proposed development and also a contribution to the annual average daily flow of the event-day traffic (an uplift factor of 1.071 has been applied to the baseline traffic rather than 1.066 to account for this).

A6.6.15 Traffic speeds have been estimated based on professional judgement, taking account of the road layout, speed limits and the proximity to a junction. The traffic data used in this assessment are summarised in Table A6.6.1 to Table A6.6.4.

Table A6.6.1: Summary of Traffic Data used in the Assessment 2014 and 2018 (AADT)

Road Link	2014		Speed (kph)
	AADT	%HDV	
1	21592	7	35
2	21592	7	35
3	21592	7	25
4	17772	8	25
5	18088	8	25
6	18088	7	25
7	18088	7	25
8	18088	7	25
9	17125	8	25
10	17125	8	35
11	17125	8	35
12	17125	8	25
13	16499	11	25
14	16499	11	35
15	16499	11	35
16	11673	6	25
17	11673	6	35
18	14092	3	25
19	14092	3	35
20	1970	2	25
21	1970	2	30
22	12318	4	20
23	12318	4	30
24	12318	4	30
25	14056	5	35
26	14056	5	35
27	18088	8	20
28	12318	4	20
29	18088	7	20
30	6785	7	25

Road Link	2014		Speed (kph)
	AADT	%HDV	
31	6785	7	35
32	1274	2	30
33	1274	2	30
34	1274	2	30
35	1274	2	30
36	7156	5	25
37	7156	5	35
38	7156	5	35
39	7156	5	35
40	21592	7	35
41	14056	5	35
42	672	4	30
43	672	4	30
44	672	4	30
45	287	1	30
46	21592	7	35

Table A6.6.2: Summary of Traffic Data used in the Assessment 2016 (AADT)

Road Link	2016 (Without Scheme)		2016 (With Scheme)		Speed (kph)
	AADT	%HDV	AADT	%HDV	
1	21592	7	21633	7	35
2	21592	7	21633	7	35
3	21592	7	21633	7	25
4	17772	8	17813	8	25
5	18088	8	18129	8	25
6	18088	7	18129	7	25
7	18088	7	18129	7	25
8	18088	7	18129	7	25
9	17125	8	17166	9	25
10	17125	8	17125	8	35
11	17125	8	17125	8	35

Road Link	2016 (Without Scheme)		2016 (With Scheme)		Speed (kph)
	AADT	%HDV	AADT	%HDV	
12	17125	8	17125	8	25
13	16499	11	16499	11	25
14	16499	11	16499	11	35
15	16499	11	16499	11	35
16	11673	6	11673	6	25
17	11673	6	11673	6	35
18	14092	3	14092	3	25
19	14092	3	14092	3	35
20	1970	2	1970	2	25
21	1970	2	1970	2	30
22	12318	4	12318	4	20
23	12318	4	12318	4	30
24	12318	4	12318	4	30
25	14056	5	14056	5	35
26	14056	5	14056	5	35
27	18088	8	18129	8	20
28	12318	4	12318	4	20
29	18088	7	18129	7	20
30	6785	7	6785	7	25
31	6785	7	6785	7	35
32	1274	2	1274	2	30
33	1274	2	1274	2	30
34	1274	2	1274	2	30
35	1274	2	1274	2	30
36	7156	5	7156	5	25
37	7156	5	7156	5	35
38	7156	5	7156	5	35
39	7156	5	7156	5	35
40	21592	7	21633	7	35
41	14056	5	14056	5	35
42	672	4	672	4	30

Road Link	2016 (Without Scheme)		2016 (With Scheme)		Speed (kph)
	AADT	%HDV	AADT	%HDV	
43	672	4	672	4	30
44	672	4	672	4	30
45	287	1	287	1	30

Table A6.6.3: Summary of Traffic Data used in the Assessment 2018 (AADT)

Road Link	2018 (Without Scheme)		2018 (With Scheme)		Speed (kph)
	AADT	%HDV	AADT	%HDV	
1	21592	7	21717	7	35
2	21592	7	21717	7	35
3	21592	7	21717	7	25
4	17772	8	17914	8	25
5	18088	8	18286	8	25
6	18088	7	18286	7	25
7	18088	7	18286	7	25
8	18088	7	18286	7	25
9	17125	8	17400	8	25
10	17125	8	17400	8	35
11	17125	8	17400	8	35
12	17125	8	17400	8	25
13	16499	11	16696	11	25
14	16499	11	16696	11	35
15	16499	11	16696	11	35
16	11673	6	11716	6	25
17	11673	6	11716	6	35
18	14092	3	14137	3	25
19	14092	3	14137	3	35
20	1970	2	2326	2	25
21	1970	2	2326	2	30
22	12318	4	12362	4	20
23	12318	4	12362	4	30
24	12318	4	12362	4	30

Road Link	2018 (Without Scheme)		2018 (With Scheme)		Speed (kph)
	AADT	%HDV	AADT	%HDV	
25	14056	5	14101	5	35
26	14056	5	14101	5	35
27	18088	8	18286	8	20
28	12318	4	12362	4	20
29	18088	7	18286	7	20
30	6785	7	6807	7	25
31	6785	7	6807	7	35
32	1274	2	1275	2	30
33	1274	2	1275	2	30
34	1274	2	1275	2	30
35	1274	2	1275	2	30
36	7156	5	7179	5	25
37	7156	5	7179	5	35
38	7156	5	7179	5	35
39	7156	5	7179	5	35
40	21592	7	21717	7	35
41	14056	5	14101	5	35
42	672	4	1028	4	30
43	672	4	1028	4	30
44	672	4	850	3	30
45	287	1	287	1	30

Table A6.6.4: Summary of Traffic Data used in the Assessment 2021 (AADT)

Road Link	2021 (Without Scheme)		2021 (With Scheme)		Speed (kph)
	AADT	%HDV	AADT	%HDV	
1	21592	7	21948	7	35
2	21592	7	21948	7	35
3	21592	7	21948	7	25
4	17772	8	18183	8	25
5	18088	8	18670	7	25
6	18088	7	18670	7	25